DETENTION BASIN CONSTRUCTION AT THE ALLEN COUNTY HOME PROPERTY 3125 ADA ROAD LIMA, OHIO 45801

PORT AUTHORITY OF ALLEN COUNTY AS FUNDED THROUGH THE OHIO DEPARTMENT OF DEVELOPMENT BROWNFIELD REMEDIATION PROGRAM GRANT, AGREEMENT ODSA – 2022 - 190745

Prepared By:

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PREPARED FOR:

THE PORT AUTHORITY OF ALLEN COUNTY
144 SOUTH MAIN STREET, STE 204
LIMA, OHIO 45801

CEC Project 324-682

DATE: MAY 2024

TABLE OF CONTENTS

FIGURES

ATTACHMENT

1.0 SITE DESCRIPTION AND EXISTING CONDITIONS

1.1 SITE LOCATION

The Allen County Home Property located at 3125 Ada Road, Lima Ohio 45801, is an 8.027-acre parcel of nonindustrial land ("Site"). The property is situated on the north side of Ada Road and west of Interstate 75 on the east side of Lima, Ohio. The location of the Site is shown on Figure 1.

1.2 SITE HISTORY

According to records available at the Allen County Recorder's Office, the Site has been in public sector control since the mid-1800s. The Allen County Auditor's Office lists the building located at 3125 Ada Road, Lima Ohio 45801 with a 1959 construction date and totaling approximately 62,000 square feet. Over the years the site has operated as a retirement home and student housing; there is no known association with any industrial activity. The building sat vacant for several years and, while the building was secure and was maintained by Allen County, was a liability.

The Port Authority of Allen County (PAAC) currently has possession of the Site and believes it has tremendous potential to be redeveloped. In the fall of 2023, the PAAC utilized grant dollars provided through the Department of Development Brownfield Remediation Program to demolish the former building. The Site is currently undeveloped.

1.3 EXISTING SITE CONDITIONS

As depicted in Figure 2, the Site is predominately undeveloped except for utility features intentionally left in place to potentially serve future Site development. Site photographs depicting the post-construction conditions of the Site are provided in Appendix A.

1.4 SPECIAL WASTES

No special waste materials are known to remain at the Site.

1.5 PREVIOUS ENVIRONMENTAL ASSESSMENTS AND CLEANUP

In July of 2017 DMD Environmental Inc, completed an Asbestos Survey for the Site. The Asbestos Survey included collection of forty-six (46) samples, six (6) of which identified Chrysotile Asbestos at concentrations of 4-60 percent. ACM within the building includes floor tiles and mastic, spray on ceiling, joints on fiberglass, and breeching thermal system insulation.

A Remedial Action Plan (RAP) was prepared by Civil and Environmental Consultants, Inc. (CEC) in March of 2022, to address the presence of building materials containing asbestos, along with hazardous building components. The RAP recommended the removal and disposal of hazardous building components and ACM prior to building demolition.

Regulated asbestos containing materials (RACM) and hazardous building components (*e.g.,* fluorescent light tubes, ballasts, hydraulic oil tank, mercury containing switches) were abated prior

to building demolition. A Construction Completion Report was prepared by CEC in March of 2024 that documents the planning and execution phases of the demolition of the former Allen County Home building. Following completion of construction activities, a No Further Action Letter (24NFA855) was prepared by Michael Coonfare, CP 298 and was submitted to Ohio EPA requesting a Covenant Not to Sue (CNS). At the time of the preparation of these specifications, the CNS is in the process of being prepared for Director signature.

An electronic copy of previous environmental studies is available upon request.

2.0 PROJECT OBJECTIVE AND SEQUENCE

The overall objective of the project is to construct a stormwater detention basin and water conveyance features in accordance with the Plan Set provided in Appendix B at the Site to provide the minimal amount of infrastructure for future redevelopment. The PAAC will submit permit applications prior to the issuance of the Notice to Proceed to Bath Township, Allen County Board of Commissioners, and Ohio EPA. PAAC envisions the project proceeding in four (4) phases; however, the means and methods of the execution of the required services are determined by the selected Contractor:

- **Phase I** – Pre-Construction Activities: Attendance at a pre-construction meeting with the PAAC and their representative to review scope of work/pay items, budgets and schedules; Submittals; Contractor mobilization; Erosion Control Installation (see detailed Construction Plan Set)
- **Phase II** – Site Preparation Activities and Earth Movement: Site preparation activities include ground surface preparation in accordance with the Construction Plan Set and ODOT Construction and Material Specifications (ODOT CMS) Section 200, Items 201, 202, 203, and 204 (dated January 1, 2023) (Appendix C-1); Earth movement activities in accordance with Sheets C300 and C301 of the Construction Plan Set and Supplemental Item 1015 (Appendix C-2) of ODOT CMS
- **Phase III** – Outlet and Water Conveyance Features Installation: Install outlet structure, water conveyance piping, and connection to existing Manhole MH1; and,
- **Phase IV** – Site Restoration: Conduct post-construction Site restoration in accordance with the Construction Plan Set.

This project is funded through the Ohio Department of Development's (Ohio DOD) Brownfield Remediation Program. A copy of the Grant Agreement between the PAAC and the Ohio DOD is provided in Appendix D. Prevailing wage rates apply to this project. The Contractor shall comply with Ohio Revised Code Sections 4115.03 through 4115.06.

A description of the scope of work associated with each Phase, as well as general conditions for the project, are presented in Sections 4.0 and 5.0, respectively.

3.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

This section presents the overall project organization and provides a general guideline for communications, reporting, and problem resolution during the execution of the project. The key project personnel include the Owner (PAAC), the PAAC's on-Site Representative (CEC), and the Contractor (and applicable subcontractors). A description of the roles and responsibilities of the key project personnel are provided below.

3.1 OWNER

The PAAC is the owner of the property and will make all final decisions.

3.2 OWNER'S REPRESENTATIVE

CEC will serve as the Owner's Representative during the execution of the project, to ensure Contractor compliance with these specifications and PAAC requirements. CEC will report directly to PAAC, and will be responsible for the following:

- Serve as the primary point of contact for the Contractor and coordinate communications with appropriate PAAC representatives,
- Monitor the Contractor's compliance with the project schedule,
- Maintain activity logs provided by the Contractor, including written and photographic documentation of project activities,
- Conduct meetings, as necessary, with the Contractor and PAAC representatives to discuss health and safety, operations, logistics, scheduling, or other project issues and,
- Maintain records associated with the completion of the project, as described in Section 5.10, and provide to the Owner as needed.

3.3 CONTRACTOR

The Contractor may elect to contract with a subcontractor(s) for completion of select portions of the project. The Contractor will be responsible for all actions and compliance with project requirements of its employees and subcontractors. During the day-to-day execution of the project, the Contractor will report directly to the Owner's Representative to resolve any scheduling, logistical, or operational conflicts. The Contractor will be responsible for the following:

- Prepare and submit a Work Plan and Safety Plan,
- Comply with all permit requirements necessary to complete the project,
- Comply with the Erosion Control Plan provided in the Construction Plan Set,
- Perform all project activities in accordance with these specifications and other contract documents,
- Provide third party soil compaction testing,
- Health and safety of its workers and subcontractors, including compliance with all regulatory requirements [Occupational Safety and Health Administration (OSHA) and National Emission Standards for Hazardous Air Pollutants (NESHAP), etc.],
- Comply with all applicable local, state, and federal laws and regulations and,

- Coordinate, schedule, and manage all subcontractors.

3.4 RELATED DOCUMENTS

Documents related to and referenced in these Specifications include:

- PAAC Request for Quotation
- PAAC Bid Sheet
- PAAC Bid Bond Form
- Contractor Affidavits and Declarations
- Previous Environmental Assessment documentation (available in electronic format by request)
- ODOT CMS (January 1, 2023)
- Eleven Sheet Construction Plan Set (April 2024) and,
- ODDBRP Grant Agreement.

4.0 SCOPE OF WORK

The Contractor will provide all supervision, competent persons, labor, tools, materials, and equipment necessary for the completion of the project described herein. All project related activities will be completed in accordance with these specifications and all applicable state, federal, and local laws and regulations.

4.1 PHASE I – PRE-CONSTRUCTION ACTIVITIES

Pay Item 01-01: General Conditions (Contractor Submittals); Mobilization; Erosion Control

The Contractor will perform the following prior to initiating any construction work on the Site:

- Attend a pre-construction meeting with the PAAC and their representative to review the pay items, budget and schedule,
- Contact Ohio Utility Protection Service,
- Required Submittals (Health and Safety Plan, Work Plan),
- Mobilize construction equipment to the Site and
- Install required erosion control features (Plan Sheets C900, C901, C902, and C903).

4.2 PHASE II – EARTH MOVEMENT

Pay Item 02-01: Site Preparation Activities:

Subgrade soil within the construction area will be used, in part, to construct the west embankment of the detention basin (see Plan Sheet C300 and Plan Sheet C301). Therefore, overburden topsoil shall be removed and stockpiled for later use as top dressing. In addition, vegetation located at the north end of the planned detention basin shall be removed and disposed offsite to allow for the construction of the detention basin. All work shall be performed in accordance with Plan Sheet C001 and ODOT CMS Item 201, Item 203, and Item 651.

Pay Item 02-02: Soil Excavation, Placement, and Compaction:

Plan Sheets C001 "General Notes", C200 "Site Plan", C300 "Grading Plan", C301 "Cross Sections", ODOT CMS Item 202, Item 204, Item 652, Item 650, and Supplemental Item S-1015 apply to this Pay Item. Approximately 3,330 cubic yards of cut is required to construct the detention basin to meet the grading plan provided on Plan Sheet C300. The on-Site fill requirements, also noted on Plan Sheet C300, results in a soil balance. Fill soil placed to form the detention basin shall be placed in 8-inch loose lifts (maximum) for compaction in accordance with ODOT CMS Item 203. Soil compaction testing shall be coordinated by the Contractor and shall comply with ODOT Supplemental Item S-1015. Soil placed as fill outside of the detention basin may be placed in 18-inch lifts and machine compacted. Soil compaction testing is not required outside of the limits of the detention basin.

4.3 PHASE III – WATER OUTLET AND WATER CONVEYANCE FEATURES INSTALLATION

Pay Item 03-01: Outlet Structure Construction and Installation:

Contractor shall install the outlet control structure in accordance with Plan Sheet C001, Plan Sheet C200, and Plan Sheet C800. Contractor shall maintain and provide an as-built / record drawings for distribution to the Owner at completion of work.

Pay Item 03-02: Eight-inch Diameter HDPE Installation and Tie-in:

Contractor shall install approximately 21 linear feet of eight-inch diameter HDPE pipe on the basin side of the outlet control structure as detailed on Plan Sheet C800. Contractor shall also install approximately 315 liner feet of eight-inch diameter HDPE on the south side of the outlet control structure and tie into manhole MH1 as shown on Plan Sheet C200.

4.4 PHASE IV SITE RESTORATION

Pay Item 04-01: Final Grade, Topsoil Placement, Seed, and Mulch

The Contractor shall utilize topsoil removed and stockpiled from the construction area as described in Pay Item 02-01 as top dressing in the fill area east of the detention basin. The Contractor will be responsible for final ground stabilization. Seeding operations shall not be performed when the ground is frozen, or when soil or weather conditions would prevent proper soil preparation and subsequent operations. The Contractor can apply fertilizer, mulch, seed, and other amendments using hydroseed methods. When hydroseeding is performed, nozzles or sprays shall not be directed toward the ground in a manner that will cause erosion or runoff. The Contractor shall notify the Owner at least 48 hours prior to beginning seeding operations. The Contractor should refer to ODOT CMS Item 659, for mulching and seeding requirements and follow any requirements pertaining to the closure of National Pollution Discharge Elimination Systems (NPDES) Construction Permit.

Seeding:
The surface of areas to be seeded shall be cleared of obstacles that might hinder the seed establishment. The Contractor shall refer to ODOT CMS Item 659 and Plan Sheets C900 through C903 for seeding specifications and requirements.

Mulching:
Immediately after seeding, mulch (hay or straw) shall be evenly applied at a minimum rate of two (2) to three (3) tons per acre (depending on the time of year) to a uniform thickness as specified in ODOT CMS Item 659.13 and 659.14. The mulch shall be spread uniformly in a continuous blanket of sufficient thickness to completely hide the soil from view. The rate of application shall be as specified and shall be considered a minimum rate. The mulch may be spread by hand or by machinery. Mulch shall be applied no later than twenty-four (24) hours after completion of the seeding operation. The Contractor shall care for the mulched areas until final acceptance of the project. Such care shall consist of providing protection against foot traffic by approved warning

signs or barricades, and repair of areas damaged by erosion, wind, or other causes. Such areas shall be repaired to re-establish the condition of the area prior to mulching and shall then be reseeded and remulched as specified in this section.

Evaluation of Revegetation Success:

The Contractor shall maintain and protect seeded areas until a uniform stand of grass at least two (2) inches in height is produced over all seeded areas. After the grass has established, all areas which fail to show a uniform stand from any cause, including a prolonged period of dry weather, shall be reseeded, except that fertilizer shall not be applied, and the seeding process shall be repeated as often as necessary until the specified areas are completely covered with grass. Any reseeding shall be performed at no additional cost to the Owner. Visual evaluations of the success of vegetation will be made by the Owner or Owners Representative six (6) weeks after seeding and germination.

5.0 GENERAL REQUIREMENTS

5.1 SITE BOUNDARY AND WORK AREA

The Site boundary is shown on Figure 2. All work activities at the Site will be performed within the Site boundary unless approved in advance by the Owner or the Owner's Representative.

5.2 SITE FACILITIES

The Contractor is responsible for providing the following:

- Equipment
- Equipment storage sheds/trailers
- Portable toilet and
- Fire protection.

The Contractor is responsible for the off-site removal of its temporary structures and disposal of any trash/rubbish it generates.

5.3 WORK RESTRICTIONS

Due to the residential property's surrounding the Site, work will not begin prior to 7:00AM and will not extend past 5:00PM.

5.4 SITE SECURITY

The Owner provides no security or surveillance of the Site. The Contractor is responsible for the security of its equipment and materials stored at the Site. The Contractor may elect to install concrete barriers or fencing as a means of protection; however, the west access drive onto the property is a shared drive with the western adjoining property. Access to the western adjoining property shall not be obstructed by any work described herein.

5.5 SITE MAINTENANCE AND HOUSEKEEPING

The Contractor will be responsible for keeping the Site clean and orderly. Upon completion of the project, the Contractor will repair any damage caused to the Site or surrounding area by returning it, at a minimum, to its original condition, and will leave the Site free of any rubbish or waste materials.

5.6 DECONTAMINATION OF PERSONNEL, EQUIPMENT, AND VEHICLES

The Contractor is responsible for the decontamination of any equipment, vehicles, or personnel leaving the Site. The Contractor will provide all materials and equipment necessary to complete decontamination activities. All contaminated materials, including decontamination fluids (if any), will be collected, containerized, and disposed of properly by the Contractor.

5.7 ENVIRONMENTAL PROTECTION

For the purpose of these specifications, environmental protection is defined as the retention of the environment in its existing state to the extent possible. Environmental protection is the responsibility of the Contractor and includes protection of air (including dust control), water, and land.

5.7.1 Dust Control

The Contractor will control dust or other airborne emissions from work areas or roads wherever a dust nuisance or hazard occurs. Controls may include sprinkling or spraying with clean water in sufficient quantities to control dust emissions but not so excessive to cause runoff from work areas or roads. Use of commercial dust suppressants (other than water) must be approved by the Owner prior to their use.

5.7.2 Stormwater Runoff

In addition to installing erosion and sedimentation controls and implementation of a Stormwater Pollution Prevention Plan, the Contractor will prevent the transport or tracking of sediment or debris via surface water runoff from Site to the surrounding areas.

5.7.3 Spills or Releases

The Contractor will take the measures necessary to prevent the spillage or release of any hazardous materials or petroleum products to the ground surface. Should such a spill or release occur, the Contractor will immediately notify the Owner's Representative and remediate the affected area.

5.7.4 Burning

No on-site burning will be permitted.

5.8 REGULATORY COMPLIANCE

The Contractor is responsible for performing all project related activities in accordance with applicable federal, state, and local laws and regulations. The Contractor is responsible for any penalties or corrective actions imposed by regulatory authorities or governmental agencies for non-compliance with laws and regulations.

5.9 TRAINING, LICENSES, PERMITS, AND NOTIFICATION REQUIREMENTS

The Contractor will obtain all permits and registrations required for the project by federal, state, and local jurisdictions and agencies. The Contractor will provide copies of applications, registrations, and permits to the Owner's Representative prior to beginning the project.

The Contractor shall possess all licenses required for the project by federal, state, and local jurisdictions and agencies. The Contractor's personnel shall possess any individual licenses

required for the project in which the person is engaged. The Contractor shall maintain copies of all such licenses at the Site for the duration of the project.

The Contractor shall ensure that its personnel working at the Site have all required training and medical certifications required for their positions and for performance of the work in which they are engaged. This includes any training required for persons defined as "competent persons" under applicable OSHA and other regulations. The Contractor shall maintain documentation of all such training and medical certifications at the Site for the duration of the project.

5.10 RECORDKEEPING AND REPORTING REQUIREMENTS

On a weekly basis throughout the duration of the project, the Contractor shall submit to the Owner's Representative: manpower timesheets, equipment usage, work log listing quantities of material removed, and work accomplished.

5.11 WASTE DISPOSAL

The Contractor shall be responsible for the loading, transportation, and disposal of all waste materials generated during the execution of the project in accordance with all disposal facility requirements. The Contractor is responsible for any penalties or corrective actions imposed by the disposal facilities for non-compliance with those requirements.

5.12 SUBMITTALS

5.12.1 Work Plan

The Contractor will submit a Work Plan to the Owner's Representative for review and approval prior to the initiation of the work. The Work Plan will, at a minimum, provide:

- A list of subcontractors used to complete the project,
- A list of required licenses, permits, and notifications required to complete the project,
- Copies of licenses and training certifications necessary to complete the project,
- Project approach and schedule, including: 1) Sequencing or phasing of work; 2) Coordination of subcontractors; and 3) Detailed schedule for completion (bar chart or equivalent) for individual phases/tasks,
- Procedures for waste handling, loading, transportation, and disposal, including the names of the permitted disposal facilities that will be used and,
- Recordkeeping, documentation, and reporting procedures in accordance with Section 5.10.

5.12.2 Health and Safety Plan

The Contractor is responsible for the health and safety of its employees and its subcontractors during all phases of the project. The Contractor also shall comply with all applicable regulatory requirements pertaining to health and safety.

Prior to the initiation of the project, the Contractor must submit to the Owner's Representative a Health and Safety Plan prepared in accordance with OSHA and other applicable regulatory requirements that will be implemented during the project.

5.12.3 Weekly Progress Reports

On a weekly basis, the Contractor must maintain records and provide a project progress report and an updated project schedule as described in Section 5.10.

5.12.4 Waste Disposal Documentation

Submit weigh slips to the Owner's Representative from the disposal facility(s) used for the ultimate disposal of waste materials to document proper disposal. Slips must identify the part of the project the waste was generated from, the name and address of the disposal facility, and the type of waste disposed.

5.12.5 Payroll Records

On a weekly basis, submit to the Owner payroll records necessary to satisfy requirements of the Ohio Prevailing Wage Law (Ohio Rev.§4115 Wages and Hours On Public Works).

5.13 PRICING AND PAYMENT

5.13.1 Pricing

The Contractor will provide lump sum costs for each bid item (task) listed on the Bid Sheet as well as a total lump sum cost to complete all project activities described in these specifications.

This project is funded through the ODDBRP. A copy of the Grant Agreement between the PAAC and the Ohio DOD is provided in Attachment D. Prevailing wage rates apply to this project. The Contractor shall comply with Ohio Revised Code Sections 4115.03 through 4115.06. The awarded contractor shall provide payroll records to the Owner on a weekly basis to verify compliance with these rates.

5.13.2 Basis of Payment

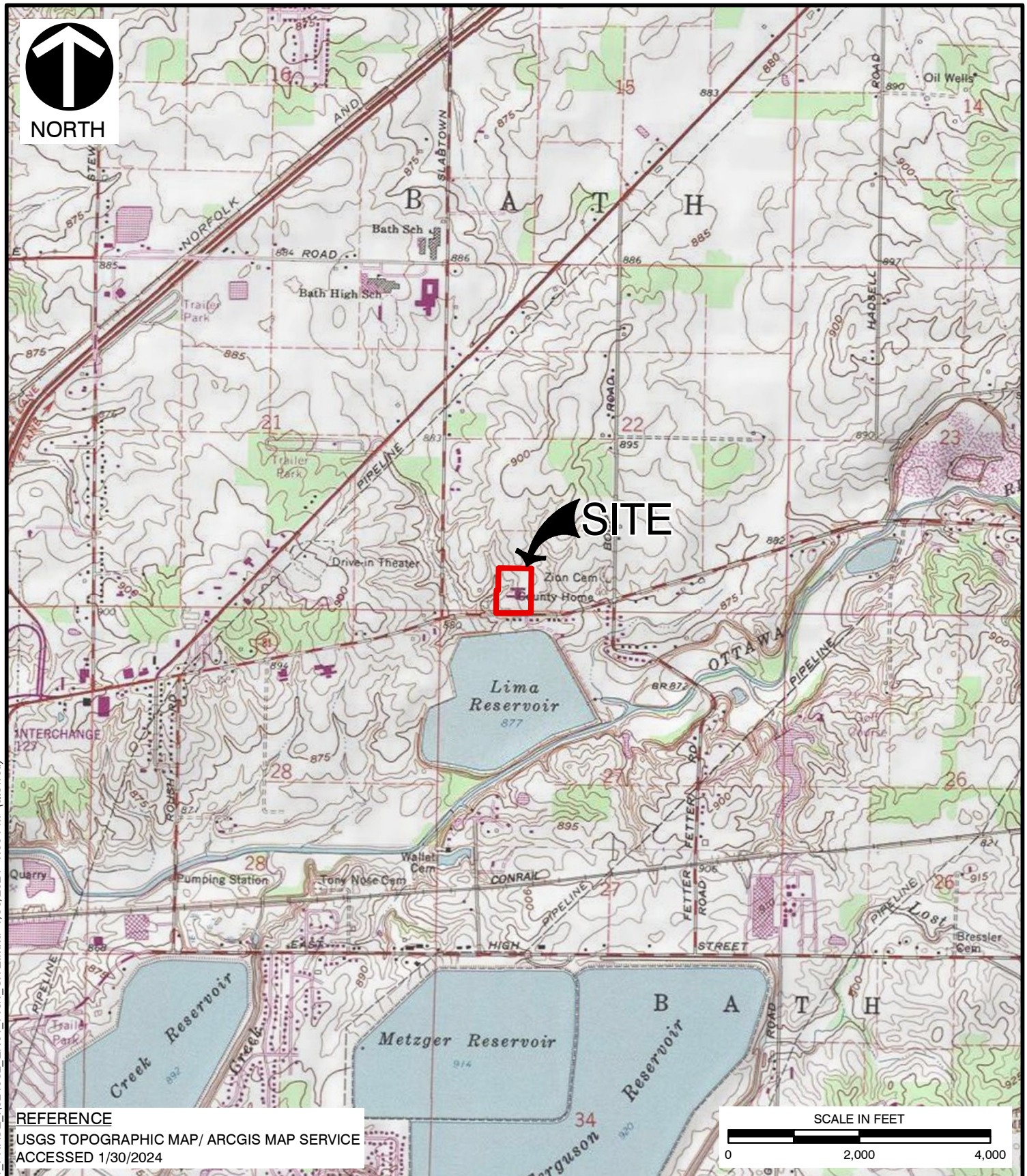
The Contractor may submit an invoice to the Owner for each task (Bid Item on Bid Sheet) after the task has been completed and all required documentation (*e.g.*, waste disposal receipts, payroll records, etc.) has been provided. Task completion will be determined and agreed upon by the Contractor and the Owner's Representative. The Contractor may submit its final invoice after Project Closeout as described in Section 5.14.

5.14 PROJECT CLOSEOUT

The project will be considered complete after all project activities have been completed, all materials and equipment have been removed from the Site (including erosion and sedimentation

controls), and the disturbed ground has been stabilized. The contractor, Owner, and Owner's Representative will perform a final site inspection to determine whether the above conditions are met. If deficiencies are noted, the Contractor will correct the deficiencies before final payment is made.

FIGURES



REFERENCE
USGS TOPOGRAPHIC MAP/ ARCGIS MAP SERVICE
ACCESSED 1/30/2024

SCALE IN FEET
0 2,000 4,000

Civil & Environmental Consultants, Inc.
One SeaGate, Suite 2050 - Toledo, OH 43604
419-724-5281 · 855-274-2324
www.cecinc.com

ALLEN COUNTY HOME PROPERTY
3125 ADA ROAD
BATH TOWNSHIP, ALLEN COUNTY, OHIO

SITE LOCATION MAP

DRAWN BY:	CLC	CHECKED BY:	MTC	APPROVED BY:	TDM*	FIGURE NO:	1
DATE:	1/30/2024	SCALE:	1 " = 2,000 '	PROJECT NO:	324-682		

* Hand signature on file

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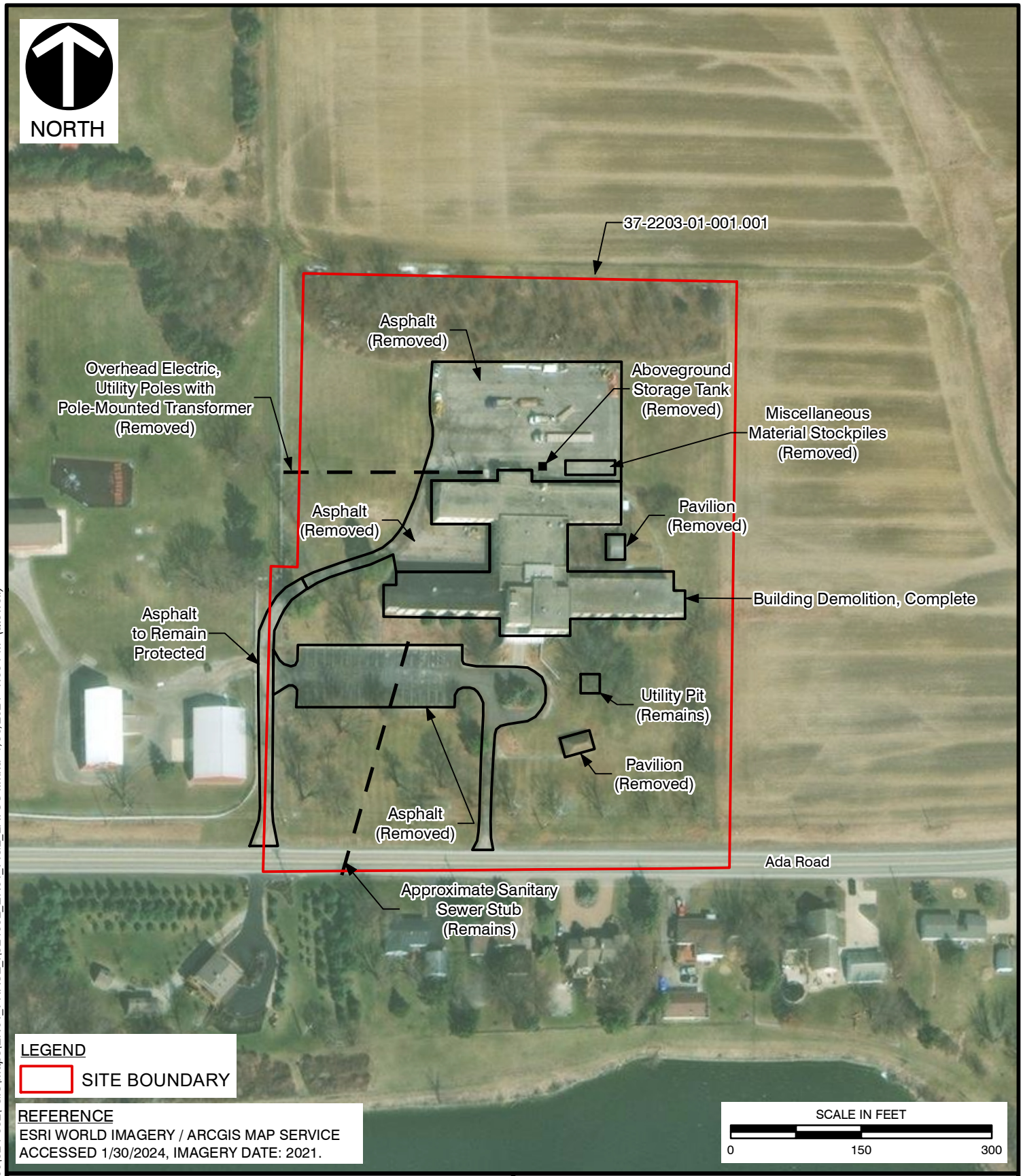

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ALLEN COUNTY HOME PROPERTY
3125 ADA ROAD
BATH TOWNSHIP, ALLEN COUNTY, OHIO

HISTORIC/CURRENT SITE FEATURES

DRAWN BY:	CLC	CHECKED BY:	MTC	APPROVED BY:	TDM*	FIGURE NO:	2
DATE:	1/30/2024	SCALE:	1 " = 150 '	PROJECT NO:	324-682		

* Hand signature on file

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APPENDIX A

SITE PHOTOGRAPHS

Photograph 1: View of the central portion of the Subject Property, standing near the south property line at Ada Road, facing north.

Photograph 2: View of the south property line of the Subject Property, standing near the southeast corner, facing west.

Photograph 3: View of the utilities along south property line of the Subject Property, standing near the southeast corner, facing north.

Photograph 4: View of the east property line of the Subject Property, standing near the southeast corner, facing north.

Photograph 5: View across the Subject Property, standing near the center of the east property line, facing west.

Photograph 6: View across the Subject Property, standing near the northeast corner, facing west.

Photograph 7: View across the Subject Property, standing near the northeast corner, facing southwest.

Photograph 8: View of the east property line of the Subject Property, standing near the northeast corner, facing south.

Photograph 9: View of the north property line of the Subject Property, standing near the northeast corner, facing west.

Photograph 10: View of the north property line of the Subject Property, standing near the northwest corner, facing east.

Photograph 11: View of the west property line of the Subject Property, standing near the northwest corner, facing south.

Photograph 12: View across the Subject Property, standing near the northwest corner, facing east.

Photograph 13: View across the Subject Property, standing near the west property line, facing southeast.

Photograph 14: View of the west property line of the Subject Property, standing along the west property line, facing south.

Photograph 15: View across the Subject Property, standing near the center of the west property line, facing east.

Photograph 16: View of the west property line of the Subject Property, standing near the southwest corner, facing north.

Photograph 17: View of the pole-mounted transformer, fire hydrant, and ingress/egress point off Ada Road (shared with west adjacent property) along the west property line of the Subject Property, facing northeast.

Photograph 18: View of the west property line of the Subject Property, standing near the southwest corner, facing north.

Photograph 19: View of the south property line of the Subject Property, standing near the southwest corner, facing east.

Photograph 20: View of the west adjacent property, standing near the southwest corner of the Subject Property, facing northwest.

Photograph 21: View of the west adjacent property, standing along the west property line, facing southwest.

Photograph 22: View of the west adjacent property, standing along the west property line, facing northwest.

Photograph 23: View of the north adjacent property, facing north.

Photograph 24: View of the east adjacent property, facing east.

Photograph 25: View of Ada Road followed by the south adjacent properties, facing southeast.

Photograph 26: View of Ada Road followed by the south adjacent properties, facing southwest.

APPENDIX B

STORM WATER MANAGEMENT CONSTRUCTION PLAN SET

PORT AUTHORITY OF ALLEN COUNTY

STORM WATER MANAGEMENT PLAN

BATH TOWNSHIP, ALLEN COUNTY, OHIO

APRIL 2024

PROJECT TEAM

OWNER

PORT AUTHORITY OF ALLEN COUNTY
144 S. MAIN STREET, SUITE 204
LIMA, OH 45801
PH: (419) 234-4781
CONTACT: CYNTHIA LEIS

CIVIL ENGINEER

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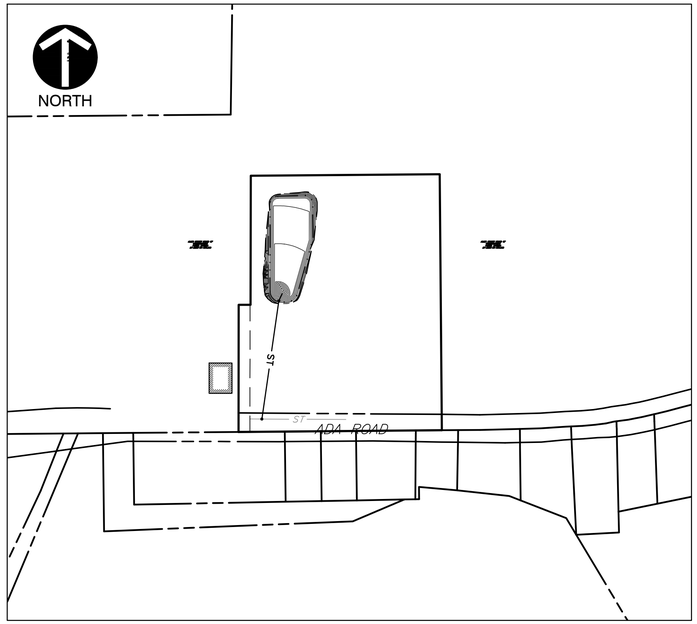
ONE SEGATE
TOLEDO, OH 43604
PH: (419) 724-5281
CONTACT: PHIL LAGGER, P.E.

BATH TOWNSHIP ZONING INFORMATION	
SITE ZONING CLASSIFICATION:	R3 RURAL DISTRICT
COUNTY PARCEL NUMBER:	37-2203-01-001.001

ZONING OF ADJACENT PROPERTIES	
NORTH:	RU RURAL DISTRICT
EAST:	RU RURAL DISTRICT
SOUTH:	R-1 RESIDENTAIL DISTRICT
WEST:	RU RURAL DISTRICT

AREA AND BULK REQUIREMENTS		
MAXIMUM STRUCTURE HEIGHT	REQUIRED	PROPOSED
PRINCIPAL STRUCTURE	---	-- FEET
MAXIMUM BUILDING COVERAGE	---%	---%
MAXIMUM IMPERVIOUS SURFACE COVERAGE	---%	---%
MINIMUM LOT AREA	10,000 SF	8.027 ACRES
MINIMUM LOT WIDTH	75 LF	--- LF
SETBACK - FRONT	50 FEET	--- FEET
SETBACK - SIDE	7.5 FEET	--- FEET
SETBACK - REAR	35 FEET	--- FEET
POND SETBACK ALL PROPERTY LINES	35 FEET	47 FEET



SITE MAP
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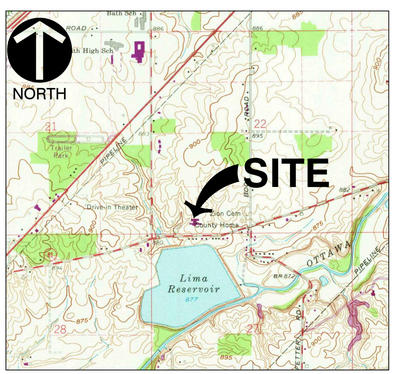
DRAWING INDEX	
Sheet Number	Sheet Title
C000	COVER SHEET
C001	GENERAL NOTES
C100	EXISTING CONDITIONS
C200	SITE PLAN
C300	GRADING PLAN
C301	CROSS SECTIONS
C800	DETENTION DETAILS
C900	SITE SWPPP
C901	SWPPP NOTES
C902	SWPPP NOTES
C903	SWPPP DETAILS



U.S.G.S. MAP
U.S.G.S. 7.5 MIN. TOPOGRAPHIC MAP,
CAIRO QUADRANGLE, OH, DATED: 2018
1"=2,000'
SCALE IN FEET
0 2000' 4000'

VICINITY MAP
BASE IMAGE FROM GOOGLE MAPS
ACCESSED MARCH 2024
1"=500'
SCALE IN FEET
0 500' 1000'

REFERENCE

1. EXISTING CONDITIONS PREPARED BY CIVIL & ENVIRONMENTAL CONSULTANTS, INC., DATED FEBRUARY, 2024.

SUBMITTAL RECORD

NO	DATE	DESCRIPTION
1		

One SeaGate
Suite 2050
Toledo, OH 43604
Ph: 419.724.5281
www.cecinc.com

Civil & Environmental Consultants, Inc.

PORT AUTHORITY OF ALLEN COUNTY
STORM WATER MANAGEMENT BASIN
3125 ADA ROAD
BATH TWP., ALLEN CO., OHIO

*HAND SIGNATURE ON FILE

COVER SHEET

DATE:	APRIL 2024
DWG SCALE:	AS SHOWN
PROJECT NO:	324-682
DRAWN BY:	RGS
CHECKED BY:	PEL
APPROVED BY:	JHR

DRAWING NO.:
C000
SHEET 1 OF 11

P:\300-001\324-682\1-CAD\dwg\C101\324682-CV01-C000.dwg(COVER SHEET) LS:(4/25/2024 - plogger) - LP: 5/20/2024 2:41 PM

GENERAL NOTES

1. EXISTING CONDITIONS AS DEPICTED ON THESE PLANS ARE GENERAL AND ILLUSTRATIVE IN NATURE. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO EXAMINE THE SITE AND BE FAMILIAR WITH EXISTING CONDITIONS PRIOR TO BIDDING ON THIS PROJECT. IF CONDITIONS ENCOUNTERED DURING EXAMINATION ARE SIGNIFICANTLY DIFFERENT FROM THOSE SHOWN, THE CONTRACTOR SHALL NOTIFY THE ENGINEER IMMEDIATELY.

2. EXISTING SITE INFORMATION / TOPOGRAPHIC SURVEY WAS PREPARED BY CEC, DATED FEBRUARY 8, 2024. CEC IS NOT RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF THE INFORMATION SHOWN

3. THE CONTRACTOR SHALL VERIFY LOCATION AND ELEVATION OF ALL EXISTING UTILITIES (INCLUDING THOSE LABELED PER RECORD DATA) PRIOR TO THE BEGINNING OF CONSTRUCTION OR EARTH MOVING OPERATIONS. INFORM ENGINEER OF ANY CONFLICTS DETRIMENTAL TO THE DESIGN INTENT.

4. 48 HOURS BEFORE DIGGING IS TO COMMENCE, THE CONTRACTOR SHALL NOTIFY THE FOLLOWING AGENCIES: THE OHIO UTILITY PROTECTION SERVICES, AND ALL OTHER AGENCIES THAT MAY HAVE UNDERGROUND UTILITIES INVOLVING THIS PROJECT AND ARE NON-MEMBERS OF OHIO UNDERGROUND PROTECTION, INC.

5. THE CONTRACTOR AND SUBCONTRACTORS SHALL BE RESPONSIBLE FOR COMPLYING WITH APPLICABLE FEDERAL, STATE AND LOCAL REQUIREMENTS, TOGETHER WITH EXERCISING PRECAUTIONS AT ALL TIMES FOR THE PROTECTION OF PERSONS (INCLUDING EMPLOYEES) AND PROPERTY. IT IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR AND SUBCONTRACTORS TO INITIATE, MAINTAIN AND SUPERVISE ALL SAFETY REQUIREMENTS, PRECAUTIONS AND PROGRAMS IN CONNECTION WITH THE WORK.

6. THE CONTRACTOR SHALL INDEMNIFY AND HOLD HARMLESS THE OWNER AND OWNER'S REPRESENTATIVE FOR ANY AND ALL INJURIES AND/OR DAMAGES TO PERSONNEL, EQUIPMENT AND/OR EXISTING FACILITIES OCCURRING IN THE COURSE OF THE DEMOLITION AND CONSTRUCTION DESCRIBED IN THE PLANS AND SPECIFICATIONS.

7. CONTRACTOR SHALL OBTAIN A PERMIT FOR ALL CONSTRUCTION ACTIVITIES IN ACCORDANCE WITH LOCAL, STATE, & FEDERAL REGULATIONS.

8. THE CONTRACTOR SHALL COMPLY WITH ALL LOCAL CODES, OBTAIN ALL APPLICABLE PERMITS, AND PAY ALL REQUIRED FEES PRIOR TO BEGINNING WORK.

9. ANY WORK PERFORMED IN THE LOCAL OR STATE RIGHT OF WAYS SHALL BE IN ACCORDANCE WITH THE APPLICABLE LOCAL OR STATE REQUIREMENTS. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO OBTAIN THE NECESSARY PERMITS FOR THE WORK, SCHEDULE NECESSARY INSPECTIONS, AND PROVIDE THE NECESSARY TRAFFIC CONTROL MEASURES AND DEVICES, ETC., FOR WORK PERFORMED IN THE RIGHT OF WAYS.

10. THE CONTRACTOR IS TO PERFORM ALL INSPECTIONS AS REQUIRED BY THE OHIO EPA FOR THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT AND FURNISH OWNERS REPRESENTATIVE WITH WRITTEN REPORTS. ALLEN COUNTY WILL OBTAIN NPDES PERMIT.

11. CONTRACTOR SHALL IMPLEMENT ALL SOIL AND EROSION CONTROL, PRACTICES REQUIRED BY ALLEN COUNTY AND THE OHIO EPA.

12. ALL GROUND SURFACE AREAS THAT HAVE BEEN EXPOSED OR LEFT BARE AS A RESULT OF CONSTRUCTION AND ARE TO FINAL GRADE AND ARE TO REMAIN SO, SHALL BE SEEDED AND MULCHED AS SOON AS PRACTICAL IN ACCORDANCE WITH SPECIFICATIONS. IF NO SPECIFICATIONS ARE SUPPLIED, USE STATE OF OHIO SPECIFICATIONS ITEM 659.

13. ITEM NUMBERS REFER TO THE OHIO DEPARTMENT OF TRANSPORTATION CONSTRUCTION AND MATERIAL SPECIFICATIONS, AND ALL CONSTRUCTION WORK SHALL BE DONE ACCORDING TO SAID SPECIFICATIONS AND IN ACCORDANCE WITH APPLICABLE STANDARDS OF ALLEN COUNTY. WHEN IN CONFLICT, THE COUNTY REQUIREMENTS SHALL PREVAIL.

14. ALL WORK PERFORMED BY THE CONTRACTOR SHALL CONFORM TO THE LATEST REGULATIONS OF THE AMERICANS WITH DISABILITIES ACT.

15. THE CONTRACTOR SHALL REFER TO OTHER PLANS WITHIN THIS CONSTRUCTION SET FOR OTHER PERTINENT INFORMATION. IT IS NOT THE ENGINEER'S INTENT THAT ANY SINGLE PLAN SHEET IN THIS SET OF DOCUMENTS FULLY DEPICT ALL WORK ASSOCIATED WITH THE PROJECT.

16. BEFORE INSTALLATION OF STORM OR SANITARY SEWER, OR OTHER UTILITY, THE CONTRACTOR SHALL VERIFY ALL CROSSINGS, BY EXCAVATION WHERE NECESSARY, AND INFORM THE OWNER AND THE ENGINEER OF ANY CONFLICTS. THE ENGINEER WILL BE HELD HARMLESS IN THE EVENT HE IS NOT NOTIFIED OF DESIGN CONFLICTS PRIOR TO CONSTRUCTION.

17. ADJUST/RECONSTRUCT ALL EXISTING CASTINGS, CLEANOUTS, ETC. WITHIN PROJECT AREA TO GRADE AS REQUIRED.

18. CONTRACTOR TO REMOVE & REPLACE PAVEMENT AS SPECIFIED.

19. SITE SIGNAGE AND STRIPING SHALL BE IN ACCORDANCE WITH THE OHIO MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES.

DEMOLITION NOTES

1. ALL EXISTING ABOVE AND BELOW GROUND STRUCTURES WITHIN THE LIMITS OF CONSTRUCTION SHALL BE REMOVED UNLESS NOTED OTHERWISE WITHIN THIS CONSTRUCTION SET AND/OR PROJECT SPECIFICATIONS. THIS INCLUDES FOUNDATION SLABS, WALLS AND FOOTINGS. CAVITIES LEFT BY STRUCTURE REMOVAL SHALL BE BACKFILLED WITH SATISFACTORY MATERIALS AND COMPACTED TO THE GEOTECHNICAL ENGINEER'S RECOMMENDATION.

2. CLEARING LIMITS SHALL BE PHYSICALLY MARKED IN THE FIELD BY THE CONTRACTOR.

3. NO TREES SHALL BE REMOVED, NOR VEGETATION DISTURBED BEYOND THE LIMITS OF CONSTRUCTION WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE OWNER'S REPRESENTATIVE.

4. TREE PROTECTION FENCING SHALL BE IN ACCORDANCE WITH THE ALLEN COUNTY STANDARDS – OR – IN ACCORDANCE WITH THE DETAILED DRAWINGS. DO NOT OPERATE OR STORE EQUIPMENT, NOR HANDLE OR STORE MATERIALS WITHIN THE DRIP LINES OF THE TREES SHOWN TO REMAIN.

5. PROTECTION OF EXISTING TREES AND VEGETATION: PROTECT EXISTING TREES AND OTHER VEGETATION INDICATED TO REMAIN IN PLACE AGAINST UNNECESSARY CUTTING, BREAKING OR SKINNING OF ROOTS, SKINNING OR BRUISING OF BARK, SMOTHERING OF TREES BY STOCKPILING CONSTRUCTION MATERIALS OR EXCAVATED MATERIALS WITHIN DRIP LINE, EXCESS FOOT OR VEHICULAR TRAFFIC, OR PARKING OF VEHICLES WITHIN DRIP LINE. PROVIDE TEMPORARY GUARDS TO PROTECT TREES AND VEGETATION TO BE LEFT STANDING.

6. ALL DEMOLITION WASTE AND CONSTRUCTION DEBRIS SHALL BECOME THE PROPERTY OF THE CONTRACTOR UNLESS OTHERWISE DESIGNATED AND SHALL BE REMOVED BY THE CONTRACTOR AND DISPOSED OF OFFSITE IN A STATE APPROVED WASTE SITE AND IN ACCORDANCE WITH ALL LOCAL AND STATE CODES AND PERMIT REQUIREMENTS. TAKE CARE TO PROTECT UTILITIES THAT ARE TO REMAIN. REPAIR DAMAGE ACCORDING TO THE APPROPRIATE UTILITY COMPANY STANDARDS AND AT THE CONTRACTOR'S EXPENSE.

7. ALL UTILITY DISCONNECTION, REMOVAL, RELOCATION, CUTTING, CAPPING AND/OR ABANDONMENT SHALL BE COORDINATED WITH THE APPROPRIATE UTILITY COMPANY / AGENCY. UTILITY CONTACTS ARE LISTED ON THE COVER SHEET.

8. THE BURNING OF CLEARED MATERIAL AND DEBRIS SHALL NOT BE ALLOWED UNLESS CONTRACTOR OBTAINS PRIOR WRITTEN AUTHORIZATION FROM THE LOCAL AUTHORITIES.

9. EROSION & SEDIMENT CONTROL MEASURES AROUND AREAS OF DEMOLITION SHALL BE PROPERLY INSTALLED AND FUNCTION PROPERLY PRIOR TO INITIALIZATION OF DEMOLITION ACTIVITIES.

10. ASBESTOS OR HAZARDOUS MATERIALS ARE NOT EXPECTED, IF FOUND ON SITE, SUCH MATERIALS SHALL BE REMOVED BY A LICENSED HAZARDOUS MATERIALS CONTRACTOR. CONTRACTOR SHALL NOTIFY OWNER IMMEDIATELY IF HAZARDOUS MATERIALS ARE ENCOUNTERED.

11. CONTRACTOR SHALL ADHERE TO ALL LOCAL, STATE, FEDERAL AND OSHA REGULATIONS DURING ALL DEMOLITION ACTIVITIES.

12. CONTRACTOR SHALL PROTECT ALL CORNER PINS, MONUMENTS, PROPERTY CORNERS AND BENCHMARKS DURING DEMOLITION ACTIVITIES. IF DISTURBED, CONTRACTOR SHALL HAVE DISTURBED ITEMS RESET BY A LICENSED SURVEYOR AT NO ADDITIONAL COST TO THE OWNER.

13. CONTRACTOR SHALL PROTECT ALL EXISTING UTILITIES, STRUCTURES, AND FEATURES TO REMAIN. ANY ITEMS TO REMAIN THAT HAVE BEEN DISTURBED OR DAMAGED AS A RESULT OF CONSTRUCTION SHALL BE REPAIRED OR REPLACED BY THE CONTRACTOR AT CONTRACTOR'S EXPENSE.

14. CONTRACTOR SHALL PROVIDE AND MAINTAIN TRAFFIC CONTROL MEASURES IN ACCORDANCE WITH STATE DEPARTMENT OF TRANSPORTATION REGULATIONS AND AS REQUIRED BY LOCAL AGENCIES WHEN WORKING IN AND/OR ALONG STREETS, ROADS, HIGHWAYS, ETC.. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO OBTAIN APPROVAL AND COORDINATE WITH LOCAL AND/OR STATE AGENCIES REGARDING THE NEED, EXTENT AND LIMITATIONS ASSOCIATED WITH INSTALLING AND MAINTAINING TRAFFIC CONTROL MEASURES.

15. PROVIDE NEAT, STRAIGHT, FULL DEPTH, SAW CUTS OF EXISTING PAVEMENT WHERE INDICATED ALONG LIMITS OF PAVEMENT DEMOLITION.

16. ALL UTILITY AND STRUCTURE REMOVAL, RELOCATION, CUTTING, CAPPING AND/OR ABANDONMENT SHALL BE COORDINATED AND PROPERLY DOCUMENTED BY A CERTIFIED PROFESSIONAL, WHEN APPLICABLE, WITH THE APPROPRIATE UTILITY COMPANY, MUNICIPALITY AND/OR AGENCY. DEMOLITION OF REGULATED ITEMS MAY INCLUDE, BUT ARE NOT LIMITED TO WELLS, ASBESTOS, UNDER GROUND STORAGE TANKS, SEPTIC TANKS AND ELECTRIC TRANSFORMERS. DEMOLITION CONTRACTOR SHALL REFER TO ANY ENVIRONMENTAL STUDIES FOR DEMOLITION RECOMMENDATIONS AND GUIDANCE. AVAILABLE ENVIRONMENTAL STUDIES MAY INCLUDE, BUT ARE NOT LIMITED TO PHASE I ESA, PHASE II, WETLAND AND STREAM DELINEATION AND ASBESTOS SURVEY. ALL APPLICABLE ENVIRONMENTAL STUDIES SHALL BE MADE AVAILABLE UPON REQUEST.

17. ALL PAVEMENT, BASE COURSES, SIDEWALKS, CURBS, BUILDINGS, FOUNDATIONS, ETC., WITHIN THE AREA TO BE DEMOLISHED SHALL BE REMOVED TO FULL DEPTH. EXISTING BASE COURSE MATERIALS MAY BE WORKED INTO THE NEW PAVEMENT OR BUILDING SUBGRADE IF THE GRADATION, CONSISTENCY, COMPACTION, SUBGRADE CONDITION, ETC., ARE IN ACCORDANCE WITH THE SPECIFICATIONS AND RECOMMENDATIONS OF THE REPORT OF GEOTECHNICAL INVESTIGATION. BASE COURSE MATERIALS SHALL NOT BE WORKED INTO THE SUBGRADE AREAS TO RECEIVE LANDSCAPING.

18. THE CONTRACTOR SHALL USE SUITABLE METHODS TO CONTROL DUST AND DIRT CAUSED BY THE DEMOLITION ACTIVITIES.

LAYOUT NOTES

1. THE CONTRACTOR SHALL CHECK EXISTING GRADES, DIMENSIONS, AND INVERTS IN THE FIELD AND REPORT ANY DISCREPANCIES TO THE OWNER'S REPRESENTATIVE PRIOR TO BEGINNING WORK.

2. THE CONTRACTOR SHALL VERIFY THE EXACT LOCATION OF ALL EXISTING UTILITIES, INCLUDING IRRIGATION LINES. TAKE CARE TO PROTECT UTILITIES THAT ARE TO REMAIN. RELOCATE EXISTING UTILITIES AS INDICATED, OR AS NECESSARY FOR CONSTRUCTION.

3. PROVIDE A SMOOTH TRANSITION BETWEEN EXISTING PAVEMENT AND NEW PAVEMENT. FIELD ADJUSTMENT OF FINAL GRADES MAY BE NECESSARY. INSTALL ALL UTILITIES, INCLUDING IRRIGATION SLEEVING, PRIOR TO INSTALLATION OF PAVED SURFACES.

4. THE CONTRACTOR SHALL PROTECT ALL TREES TO REMAIN IN ACCORDANCE WITH THE SPECIFICATIONS.

5. SITE WORK CONCRETE WALKS AND PADS SHALL HAVE A BROOM FINISH TO ALL SURFACES. SITE WORK CONCRETE SHALL BE CLASS "QC1" (4000 PSI @ 28 DAYS) UNLESS OTHERWISE NOTED.

6. ALL DAMAGE TO EXISTING PAVEMENT TO REMAIN, WHICH RESULTS FROM THE CONTRACTOR'S OPERATIONS SHALL BE REPLACED WITH LIKE MATERIALS AT THE CONTRACTOR'S EXPENSE.

7. SITE DIMENSIONS SHOWN ARE TO THE FACE OF CURB, OR EDGE OF PAVEMENT UNLESS OTHERWISE NOTED.

8. COORDINATES ARE FOR BUILDING COLUMNS, EXTERIOR BUILDING WALL, CENTER OF DRIVEWAYS, CENTER OF SANITARY SEWER MANHOLES, AND CENTER OF STRUCTURE PLACED SIX INCHES INSIDE FACE OF CURB FOR DRAIN INLETS, UNLESS OTHERWISE NOTED.

9. CONTRACTOR SHALL MAINTAIN ONE SET OF AS-BUILT / RECORD DRAWINGS ON-SITE DURING CONSTRUCTION FOR DISTRIBUTION TO THE OWNER AND/OR OWNER'S REPRESENTATIVE UPON COMPLETION.

10. REFER TO THE ARCHITECTURAL, PLUMBING & ELECTRICAL DRAWINGS FOR EXACT DIMENSIONS AND LOCATIONS OF UTILITY SERVICE ENTRY LOCATIONS AND PRECISE BUILDING DIMENSIONS.

11. THIS SITE LAYOUT IS SPECIFIC TO THE APPROVALS NECESSARY FOR THE CONSTRUCTION IN ACCORDANCE WITH BATH TOWNSHIP AND ALLEN COUNTY. NO CHANGES TO THE SITE LAYOUT ARE ALLOWED WITHOUT THE WRITTEN APPROVAL OF THE ENGINEER. CHANGES MADE TO THE SITE LAYOUT WITHOUT APPROVAL IS SOLELY THE RESPONSIBILITY OF THE CONTRACTOR. CHANGES INCLUDE BUT ARE NOT LIMITED TO, INCREASED IMPERVIOUS PAVEMENT, ADDITION / DELETION OF PARKING SPACES, MOVEMENT OF CURB LINES, CHANGES TO DRAINAGE STRUCTURES AND PATTERNS, LANDSCAPING, ETC.

GRADING NOTES

1. ALL PROPOSED GRADES SHOWN ARE FINAL GRADES, TOP OF GROUND LEVEL, OR TOP OF PAVEMENT, OR GRATE ELEVATION AT THE DRAWDOWN POINT, UNLESS INDICATED OTHERWISE.

2. ALL ELEVATIONS SHOWN ARE FINISHED GRADE ELEVATIONS.

3. CONTRACTOR SHALL STRICTLY ADHERE TO THE EROSION & SEDIMENT CONTROL PLAN PREPARED FOR THIS PROJECT.

4. EARTHWORK SHALL INCLUDE CLEARING AND GRUBBING, STRIPPING AND STOCKPILING TOPSOIL, MASS GRADING, EXCAVATION, FILLING, UNDER CUT AND REPLACEMENT, IF REQUIRED, AND COMPACTION.

5. CONTRACTOR TO REFILL UNDERCUT AREAS WITH SUITABLE MATERIAL AND COMPACT AS RECOMMENDED BY THE GEOTECHNICAL ENGINEER.

6. PLACE TOPSOIL OVER THE SUBGRADE OF UNPAVED, DISTURBED AREAS TO A DEPTH INDICATED ON THE LANDSCAPE PLANS (6" MINIMUM).

7. ALL SLOPES IN NON-PAVED AREAS SHALL BE 3:1 (HORIZONTAL:VERTICAL) MAXIMUM UNLESS NOTED OTHERWISE.

8. ALL AREAS NOT PAVED SHALL BE STABILIZED IN ACCORDANCE WITH THE EROSION & SEDIMENT CONTROL PLAN, UNLESS NOTED OTHERWISE.

9. COMPACTED FILLS ARE TO BE MADE TO A MINIMUM OF THREE FEET ABOVE THE CROWN OF ANY PROPOSED SEWER PRIOR TO CUTTING OF TRENCHES FOR PLACEMENT OF SAID SEWERS. ALL FILLS SHALL BE CONTROLLED, COMPACTED, AND INSPECTED BY AN APPROVED TESTING LABORATORY OR AN INSPECTOR FROM THE APPROPRIATE GOVERNMENTAL AGENCY.

10. TOPSOIL VOLUMES ESTIMATED AS PART OF THIS PROJECT ASSUME THAT A MINIMUM OF 12 INCHES OF SOIL AND TOPSOIL WILL BE STRIPPED FROM THE SITE. THE ACTUAL VOLUME WILL BE BASED ON EQUIPMENT USED AND THE CONTRACTOR'S MEANS AND METHODS. CEC AND THE OWNER ARE NOT RESPONSIBLE FOR THE CONTRACTOR'S INTERPRETATION OF TOPSOIL THICKNESS AND RESULTING INCREASED VOLUMES. NO ADDITIONAL COSTS WILL BE PAID TO THE CONTRACTOR FOR AN INCREASE IN THE VOLUME OF TOPSOIL STRIPPED AND STOCKPILED.

STORM DRAINAGE NOTES

1. DISTANCES SHOWN ON PIPING ARE HORIZONTAL DISTANCES FROM CENTER OF STRUCTURE TO CENTER OF STRUCTURE, UNLESS OTHERWISE NOTED.

2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL COSTS ASSOCIATED WITH THE INSTALLATION, INSPECTION, TESTING AND FINAL ACCEPTANCE OF ALL NEW STORMWATER MANAGEMENT FACILITIES CONSTRUCTION. CONTRACTOR SHALL COORDINATE WITH ALL APPLICABLE REGULATING AGENCIES CONCERNING INSTALLATION, INSPECTION AND APPROVAL OF THE STORM DRAINAGE SYSTEM CONSTRUCTION.

3. ALL STORMWATER MANAGEMENT FACILITIES, INCLUDING COLLECTION AND CONVEYANCE STRUCTURES SHALL BE INSTALLED IN ACCORDANCE WITH ALL APPLICABLE LOCAL AND STATE CODES AND REGULATIONS.

4. ANY FIELD TILE CUT IN EXCAVATION, WHICH DRAINS AN OFFSITE AREA, MUST BE TIED INTO THE STORM DRAINAGE SYSTEM.

5. ALL PROPOSED STORM SEWERS, SURFACE OR OTHER DRAINAGE FACILITIES ARE TO BE PRIVATE AND MAINTAINED BY THE OWNER.

6. ALL STORM STRUCTURES ARE ODOT TYPES UNLESS OTHERWISE INDICATED.

7. ALL CATCH BASINS AND MANHOLES WITH A DEPTH GREATER THAN 4' SHALL BE PROVIDED WITH STEPS. STEPS SHALL MEET THE REQUIREMENTS OF ODOT SPECIFICATION ITEM 711.31.

8. STORM SEWER PIPE LABELED "<STM>" SHALL BE ONE OF THE FOLLOWING: HIGH DENSITY POLYETHYLENE N-12 PER ODOT NO. 707.33. STORM SEWER PIPE LABELED "RCP" SHALL BE REINFORCED CONCRETE PIPE.

9. STORM SEWER IS TO BE BEDDED WITH CLEAN GRANULAR MATERIAL-AGGREGATES NOT TO BE LARGER THAN 3/4" AND NOT SMALLER THAN NO. 8 SIEVE, FREE OF SILT AND FINES, AASHTO M43 SIZE #67, 7 OR 8. BEDDING TO BE MINIMUM OF 6" BELOW & 12" ABOVE THE PIPE.

REFERENCE

1. EXISTING CONDITIONS PREPARED BY CIVIL & ENVIRONMENTAL CONSULTANTS, INC., DATED FEBRUARY, 2024.

P:\320-0001\324-6821-CAD\DWG\CIVIL\324682-CIV1-C000.dwg[GENERAL NOTES] 5/14/2024 - plagger - LP: 5/20/2024 2:43 PM

SUBMITTAL RECORD

NO	DATE	DESCRIPTION
1		

One SeaGate
Suite 2050
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Ph: 419.724.5281
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Civil & Environmental Consultants, Inc.

PORT AUTHORITY OF ALLEN COUNTY
STORM WATER MANAGEMENT BASIN
3125 ADA ROAD
BATH TWP., ALLEN CO., OHIO

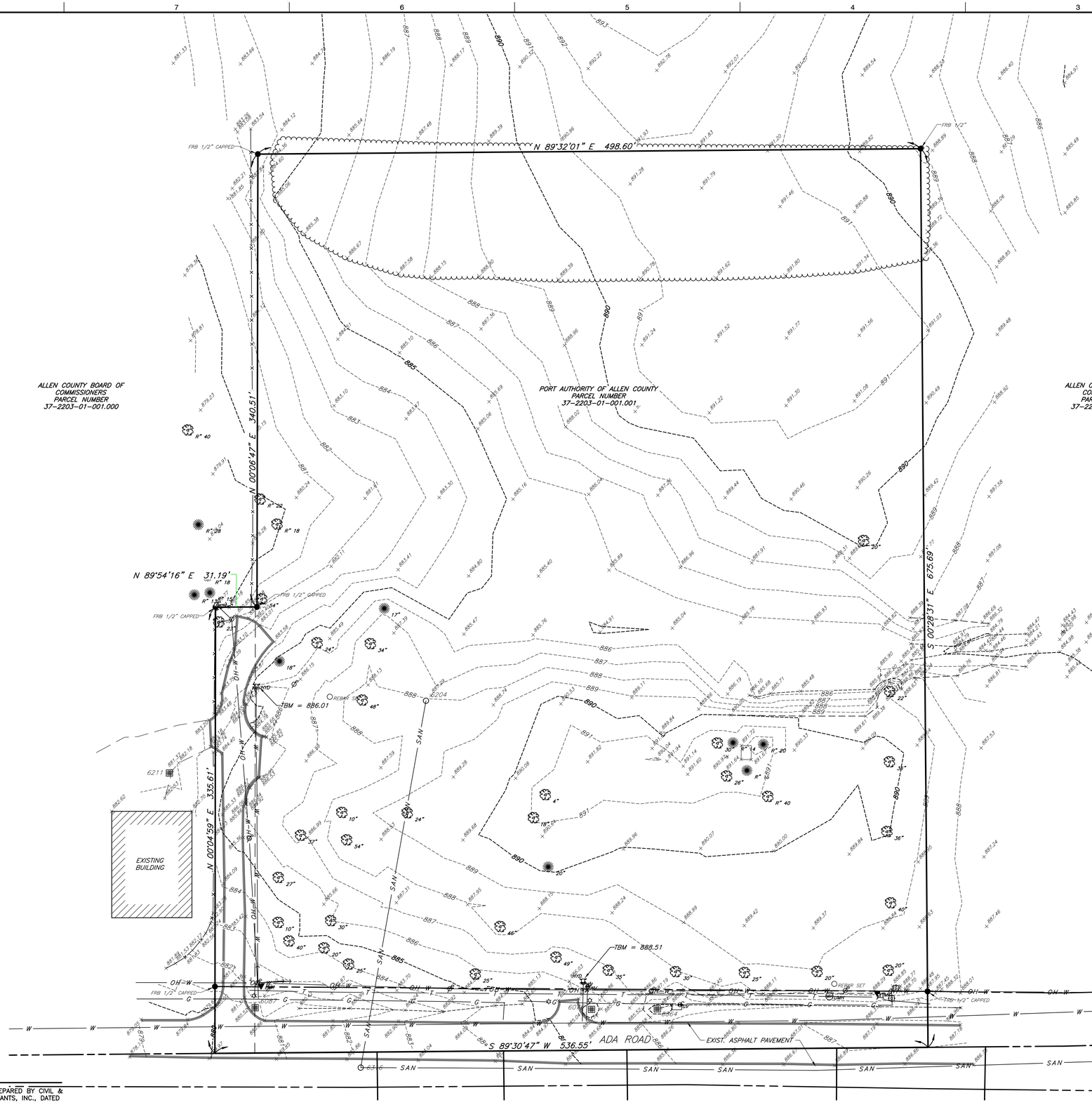
*HAND SIGNATURE ON FILE

GENERAL NOTES

DATE:	APRIL 2024
DWG SCALE:	AS SHOWN
PROJECT NO.:	324-682
DRAWN BY:	RGS
CHECKED BY:	PEL
APPROVED BY:	JHR

DRAWING NO.:
C001
SHEET 2 OF 11

NORTH



EXISTING UTILITY STRUCTURE SCHEDULE

STRUCTURE TYPE	ID	RIM	PIPE SIZE	DIRECTION	INVERT
EX. CATCH BASIN	#6064	884.22	8"	W	880.61
EX. CATCH BASIN	#6076	883.46	8"	E	879.64
			18"	NE	879.25
			8"	W	879.44
EX. CATCH BASIN	#6087	880.03	8"	E	875.10
			8"	W	874.88
EX. SANITRAY MANHOLE	#6204	888.45	-	S	878.25
			-	N	878.55
EX. CATCH BASIN	#6211	881.39	6"	SE	878.80
			6"	W	878.59

EXISTING LEGEND:

- EXISTING PROPERTY LINE
- EXISTING ADJACENT PROPERTY LINE
- EXISTING RIGHT-OF-WAY
- 870 EXISTING INDEX CONTOUR
- EXISTING INTERMEDIATE CONTOUR
- EXISTING FENCE
- ST EXISTING STORM SEWER LINE
- G EXISTING GAS LINE
- W EXISTING WATER LINE
- T EXISTING TELEPHONE LINE
- OH-W EXISTING OVERHEAD ELECTRIC
- EXISTING TREELINE
- 884.82 EXISTING SPOT ELEVATION
- TEMPORARY BENCHMARK
- IRON PIN FOUND
- SECTION CORNER MON.
- REBAR IRON PIN SET & CAP
- STORM MANHOLE
- INLET SQUARE
- WATER BOX (WATER VALVE)
- FIRE HYDRANT
- MANHOLE (UTILITY UNKNOWN)
- SIGN
- LIGHT STANDARD
- TREE, DECIDUOUS (800 SIZE TYPE)
- TREE, CONIFER (800 SIZE TYPE)
- BUSH/SHRUB (SIZE)
- POWER POLE
- GUY WIRE
- FIBER OPTIC MARKER
- GAS BOX (GAS VALVE)
- GAS METER

SCALE IN FEET
0 40 80

REFERENCE

1. EXISTING CONDITIONS PREPARED BY CIVIL & ENVIRONMENTAL CONSULTANTS, INC., DATED FEBRUARY, 2024.

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SUBMITTAL RECORD

NO	DATE	DESCRIPTION

One SeaGate
Suite 2050
Toledo, OH 43604
Ph: 419.724.5281
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CEC
Civil & Environmental Consultants, Inc.

PORT AUTHORITY OF ALLEN COUNTY
STORM WATER MANAGEMENT BASIN
3125 ADA ROAD
BATH TWP., ALLEN CO., OHIO

*HAND SIGNATURE ON FILE

EXISTING CONDITIONS

DATE:	APRIL 2024
DRAWN BY:	RGS
CHECKED BY:	PEL
DWG SCALE:	1" = 40'
PROJECT NO:	324-682
APPROVED BY:	JHR

DRAWING NO.:
C100
SHEET 3 OF 11

NORTH

FRB 1/2" CAPPED

N 89°32'01" E 498.60'

FRB 1/2"

35' POND SETBACK

54'

51'

112'

REMOVE VEGETATION AS NECESSARY TO CONSTRUCT DETENTION AREA

35' POND SETBACK

113'

251'

ALLEN COUNTY BOARD OF COMMISSIONERS PARCEL NUMBER 37-2203-01-001.000

PORT AUTHORITY OF ALLEN COUNTY PARCEL NUMBER 37-2203-01-001.001

ALLEN COUNTY BOARD OF COMMISSIONERS PARCEL NUMBER 37-2203-01-001.000

N 00°06'47" E 340.51'

R" 40

R" 22

R" 28

R" 18

47'

79'

N 89°54'16" E 31.19'

R" 18

R" 15

FRB 1/2" CAPPED

FRB 1/2" CAPPED

54'

REGRADE AREA WITH SPOILS

S 00°28'31" E 675.69'

21 LF 8" HDPE @ 8.1%

OUTLET STRUCTURE

ODOT WQ1.1 CB
RIM=884.00
INV. IN (8"NE)=879.67
INV. OUT (8"S)=880.00

TBM = 886.01

RIVER SET

6204

6211

882.62

882.70

EXISTING BUILDING

N 00°04'59" E 335.61'

115 LF 8" HDPE @ 0.0%

TBM = 888.51

REBAR SET

CMP

FRB 1/2" CAPPED

6087

6064

6063

S 89°30'47" W 536.55'

ADA ROAD

EXIST. ASPHALT PAVEMENT

ODOT MH NO. 3
RIM=881.21
INV. IN (8"N)=880.00

MH1

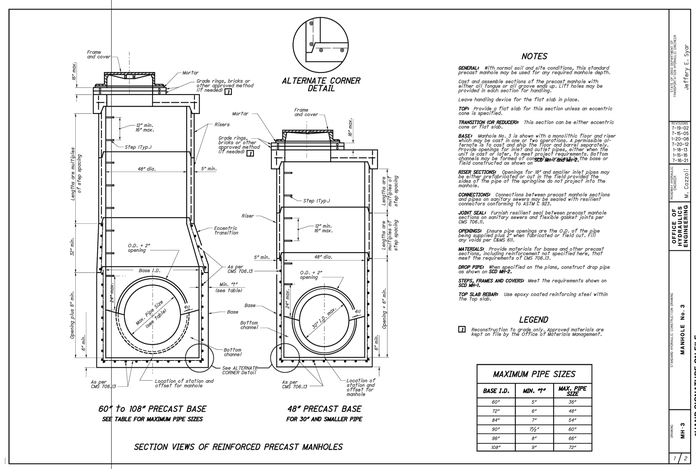
63.16

REFERENCE

1. EXISTING CONDITIONS PREPARED BY CIVIL & ENVIRONMENTAL CONSULTANTS, INC., DATED FEBRUARY, 2024.

LEGEND

- EXISTING PROPERTY LINE
- EXISTING EASEMENT
- EXISTING RIGHT-OF-WAY
- 385 EXISTING INDEX (MAJOR) CONTOUR
- EXISTING INTERMEDIATE (MINOR) CONTOUR
- EXISTING DRAINAGE DITCH
- EXISTING FENCE LINE
- EXISTING ROADWAY CENTERLINE
- EXISTING CURB
- EXISTING EDGE OF PAVEMENT
- EXISTING ASPHALT PAVEMENT
- EXISTING STRUCTURE
- ST EXISTING STORM PIPE
- W EXISTING WATER LINE
- SAN EXISTING SANITARY SEWER LINE
- G EXISTING GAS LINE
- OH-W EXISTING OVERHEAD WIRE
- E EXISTING ELECTRIC LINE
- UG-E EXISTING UNDERGROUND ELECTRIC LINE
- FO EXISTING FIBER OPTIC LINE
- EXISTING STREAM
- EXISTING WETLAND
- EXISTING FLOODWAY
- EXISTING GUIDE RAIL
- ST PROPOSED STORM PIPE
- ST PROPOSED STORM MANHOLE
- PROPOSED LIMITS OF DETENTION POND
- P18 PROPOSED PIPE LABEL



SCALE IN FEET
0 40 80

SUBMITTAL RECORD

NO	DATE	DESCRIPTION

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www.cecinc.com

Civil & Environmental Consultants, Inc.

PORT AUTHORITY OF ALLEN COUNTY
STORM WATER MANAGEMENT BASIN
3125 ADA ROAD
BATH TWP., ALLEN CO., OHIO

SITE PLAN

DATE:	APRIL 2024
DWG SCALE:	1" = 40'
PROJECT NO:	324-682
DRAWN BY:	RGS
CHECKED BY:	PEL
APPROVED BY:	JHR

*HAND SIGNATURE ON FILE

DRAWING NO.:
C200
SHEET 4 OF 11

P:\300-2001\324-6821-CAD\dwg\CV01\324682-CV01-C200.dwg|SITE PLAN| LS|5/20/2024 - plogan| - LP: 5/20/2024 2:44 PM

NORTH

LEGEND

- EXISTING PROPERTY LINE
- EXISTING EASEMENT
- EXISTING RIGHT-OF-WAY
- EXISTING INDEX (MAJOR) CONTOUR
- EXISTING INTERMEDIATE (MINOR) CONTOUR
- EXISTING DRAINAGE DITCH
- EXISTING FENCE LINE
- EXISTING ROADWAY CENTERLINE
- EXISTING CURB
- EXISTING EDGE OF PAVEMENT
- EXISTING ASPHALT PAVEMENT
- EXISTING STRUCTURE
- EXISTING STORM PIPE
- EXISTING WATER LINE
- EXISTING SANITARY SEWER LINE
- EXISTING GAS LINE
- EXISTING OVERHEAD WIRE
- EXISTING ELECTRIC LINE
- EXISTING UNDERGROUND ELECTRIC LINE
- EXISTING FIBER OPTIC LINE
- EXISTING STREAM
- EXISTING WETLAND
- EXISTING FLOODWAY
- EXISTING GUIDE RAIL
- PROPOSED LIMITS OF DISTURBANCE
- PROPOSED INDEX (MAJOR) CONTOUR
- PROPOSED INTERMEDIATE (MINOR) CONTOUR
- PROPOSED SLOPE LABEL
- PROPOSED SPOT ELEVATION

21 LF 8" HDPE @ 8.1%

OUTLET STRUCTURE — ODOT WQ1.1 CB
RIM=884.00
INV. IN (8"NE)=879.67
INV. OUT (8"S)=880.00

TBM = 886.01

REFERENCE

1. EXISTING CONDITIONS PREPARED BY CIVIL & ENVIRONMENTAL CONSULTANTS, INC., DATED FEBRUARY, 2024.

SCALE IN FEET
0 20 40

SUBMITTAL RECORD

NO	DATE	DESCRIPTION

One SeaGate
Suite 2050
Toledo, OH 43604
Ph: 419.724.5281
www.cecinc.com

Civil & Environmental Consultants, Inc.

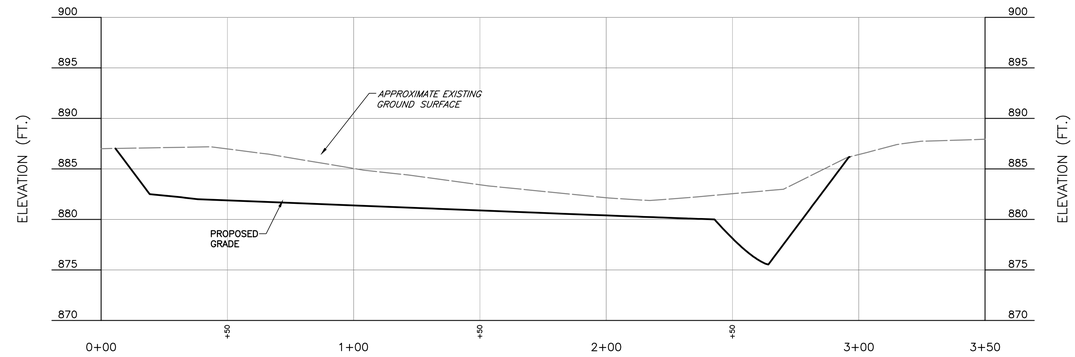
PORT AUTHORITY OF ALLEN COUNTY
STORM WATER MANAGEMENT BASIN
3125 ADA ROAD
BATH TWP., ALLEN CO., OHIO

*HAND SIGNATURE ON FILE

GRADING PLAN

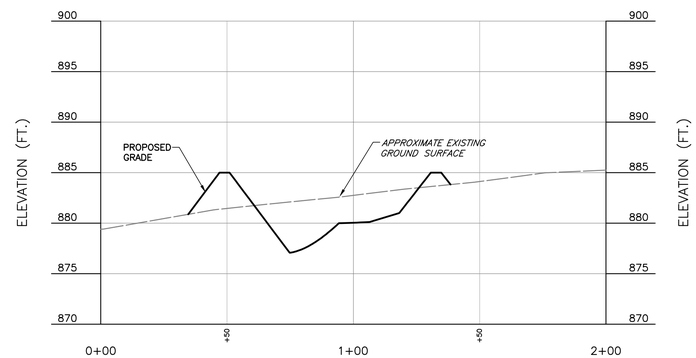
DATE:	APRIL 2024	DRAWN BY:	RGS
DWG SCALE:	1" = 20'	CHECKED BY:	PEL
PROJECT NO:			324-682
APPROVED BY:			JHR

DRAWING NO.:
C300
SHEET 5 OF 11



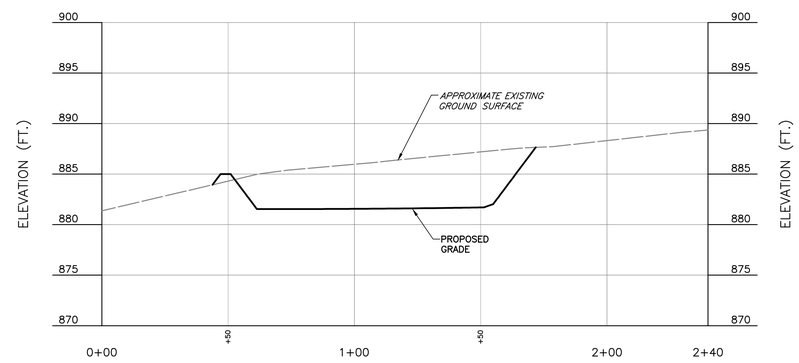
SECTION C-C

SCALE H:1"=30'; V:1"=8'



SECTION B-B

SCALE H:1"=30'; V:1"=8'



SECTION A-A

SCALE H:1"=30'; V:1"=8'

SCALE IN FEET (HORIZONTAL)

0 30 60

SCALE IN FEET (VERTICAL)

0 8 16

REFERENCE

1. EXISTING CONDITIONS PREPARED BY CIVIL & ENVIRONMENTAL CONSULTANTS, INC., DATED FEBRUARY, 2024.

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SUBMITTAL RECORD

NO	DATE	DESCRIPTION

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Ph: 419.724.5281
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PORT AUTHORITY OF ALLEN COUNTY
STORM WATER MANAGEMENT BASIN
3125 ADA ROAD
BATH TWP., ALLEN CO., OHIO

*HAND SIGNATURE ON FILE

CROSS SECTIONS

DATE:	APRIL 2024
DRAWN BY:	RGS
DWG SCALE:	AS NOTED
CHECKED BY:	DRAFT
PROJECT NO.:	324-682
APPROVED BY:	DRAFT

DRAWING NO.:

C301

SHEET 6 OF 11

10 YEAR STORMWATER DETENTION REQUIRED

BY: PEL DATE: 3-13-24

JOB NAME: **Allen County Home Site** JOB NO.: 331-354

TOTAL AREA (SQ. FT.):	324,972	7.460 Ac.	Notes: Detention Pond Calcs.
ALLOWABLE AREA (SQ. FT.)	324,972	7.460 Ac.	Design Year: 100
			Time of Concentration: 20
TOTAL IMPERVIOUS (SQ. FT.):	227,480		WT. C = Cw = 0.75
PERVIOUS (SQ. FT.):	97,492		
			ALLOW C = 0.200
			ALLOW I = 2.15
			Q Allow (cfs) = 3.20

DETENTION VOLUME CALCULATION

tc	i10	CwA	Qin	Qout=	Qin-Qout	Qin-Qout xtcx60
10.00	5.40	5.60	30.21	3.20	27.01	16208.31
20.00	4.00	5.60	22.38	3.20	19.18	23016.61
30.00	3.20	5.60	17.90	3.20	14.70	26467.76
40.00	2.70	5.60	15.11	3.20	11.91	28576.05
50.00	2.40	5.60	13.43	3.20	10.23	30684.34
60.00	2.10	5.60	11.75	3.20	8.55	30778.34
70.00	1.90	5.60	10.63	3.20	7.43	31208.05
80.00	1.50	5.60	8.39	3.20	5.19	24923.47
90.00	1.40	5.60	7.83	3.20	4.63	25017.47
100.00	1.30	5.60	7.27	3.20	4.07	24440.04

DETENTION/WATER QUALITY VOLUME CALCULATIONS

DETENTION AREA

WQV = Rv*P*(A/12) Volume Required by the Ohio EPA

Rv. = 0.68 Rv = 0.05 + 0.9i i = 70 %
(i = percent of site that is impervious)

P:= 0.9 Precipitation Depth (in)

A:= 7.46 Area Draining into the BMP (Acres)

Volume Required:

WQV:= Rv*P*(A/12) = 0.380 acre/ft WQV = 16573 ft^3

$WQV_{20\%}$: = WQV + 0.20*WQV = 19887 ft^3 WQV x 20% for Sediment Storage 3315 ft^3

Detention_Volume_Required:= 37,667 ft^3

Total_Detention_Volume:= Detention_Volume_Required + $WQV_{20\%}$ = 57554 ft^3

ORIFICE SIZE FOR WATER QUALITY VOLUME

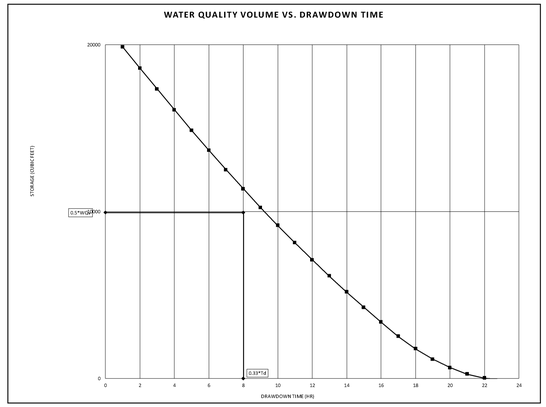
WQV:= Rv*P*(A/12) = 0.380 acre/ft WQV = 16573 ft^3

Qavg = 0.1918 cfs

Assumed head = 2.25 Average Head = 1.126309

Area (a) = 0.03754 ft 0.049087385 Area of Orifice Specified (ft)

Diameter (d) Calculated = 2.62341 in. 3 Dia. of Orifice Specified (inches)



ORIFICE SIZING FOR 10 YEAR DETENTION VOLUME

ORIFICE SIZING EQUATION: Q = CA 2gh
Q = ORIFICE DISCHARGE RATE
= 3.20 cfs (ALLOWABLE DISCHARGE) – 0.422 cfs (MAX. WATER QUALITY DISCHARGE)
= 2.778 cfs
C = COEFFICIENT OF DISCHARGE = 0.6
A = AREA OF ORIFICE = LENGTH x WIDTH
h = HYDRAULIC HEAD = 0.346 FT
g = 32.2 FT/S

ASSUMING 4 INCHES FOR THE HEIGHT OF THE ORIFICE WE CAN SOLVE FOR THE LENGTH:

A = Q/(C$\sqrt{2gh}$)
A = 0.98085 FT^2
L = 0.98085x144/4
L = 35.3 IN (USE 35 IN)

AREA USED = 4*35/144 = 0.972 FT^2
Q = 2.723 cfs < 2.778 cfs ALLOWABLE

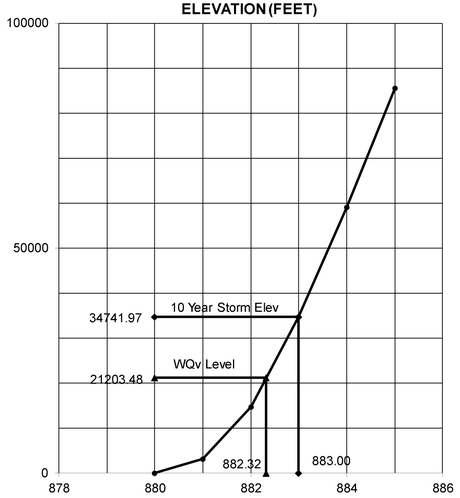
Detention Area Volumes

Elev	Area	Volume	Cum Volume
880	44	0	0
881	6506	3275	3275
882	16633	11569.5	14844.5
883	23292	19962.5	34807
884	25337	24314.5	59121.5
885	27438	26387.5	85509

Micro Pool Area Volumes

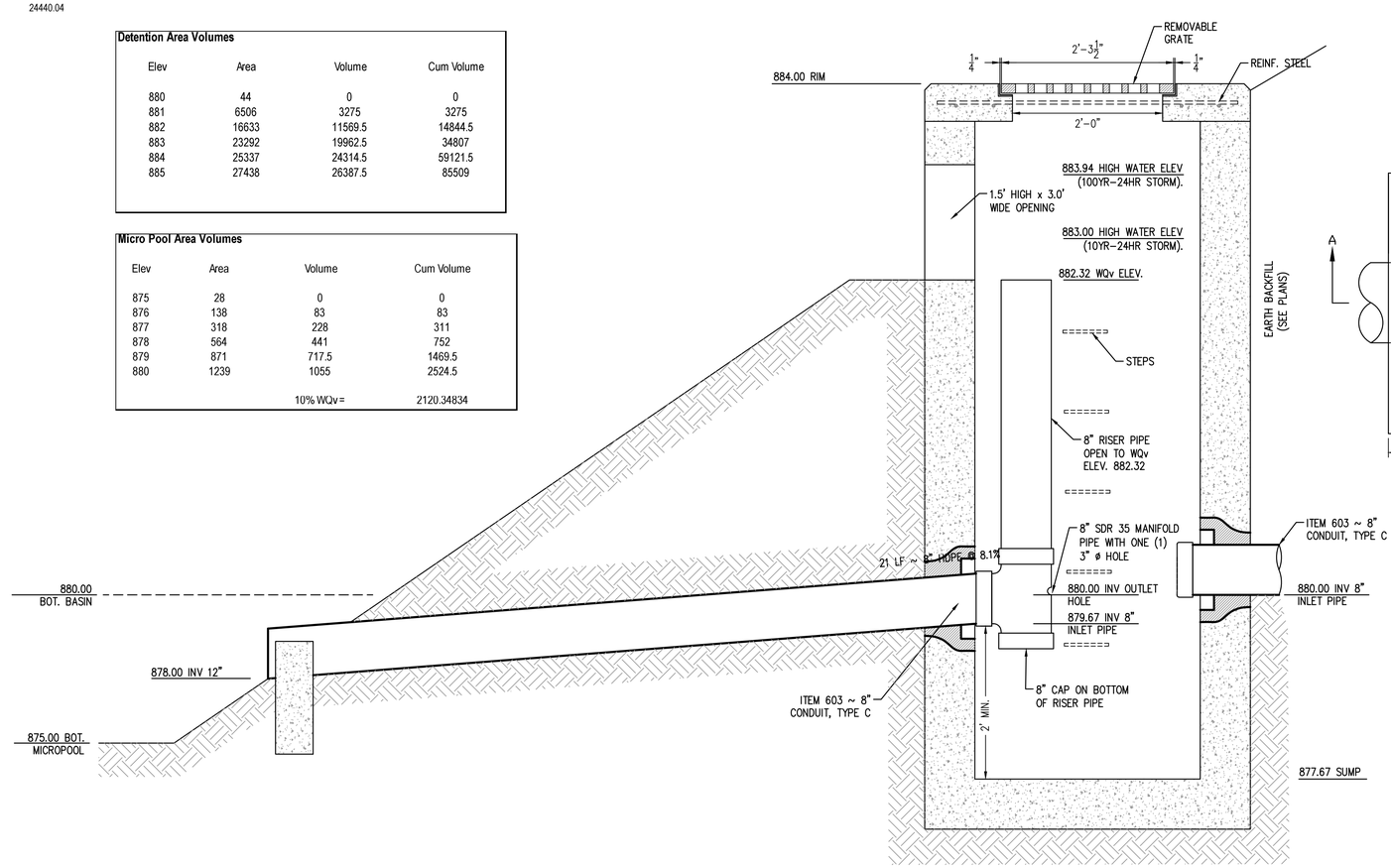
Elev	Area	Volume	Cum Volume
875	28	0	0
876	138	83	83
877	318	228	311
878	564	441	752
879	871	717.5	1469.5
880	1239	1055	2524.5
		10% WQv =	2120.34834

DETENTION POND STORAGE - ELEVATION CURVE



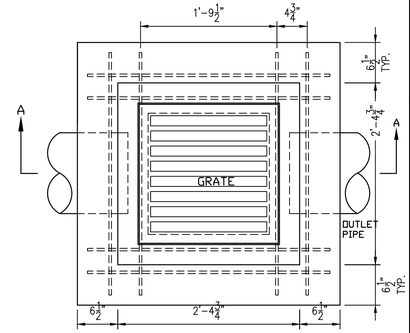
From Pond Bottom

ELEV.	STORAGE (CU. FT.)
880	0
881	3275
882	14845
883	34807
884	59122
885	85509



SECTION A-A (DETENTION)

(ODOT WQ1.1 CB)



PLAN VIEW (DETENTION)

(ODOT WQ1.1 CB)

OUTLET CONTROL STRUCTURE DETAIL - POST CONSTRUCTION

SCALE = NTS

REFERENCE

1. EXISTING CONDITIONS PREPARED BY CIVIL & ENVIRONMENTAL CONSULTANTS, INC., DATED FEBRUARY, 2024.

SUBMITTAL RECORD

NO	DATE	DESCRIPTION
1		

One SeaGate
Suite 2050
Toledo, OH 43604
Ph: 419.724.5281
www.cecinc.com

Civil & Environmental Consultants, Inc.

PORT AUTHORITY OF ALLEN COUNTY
STORM WATER MANAGEMENT BASIN
3125 ADA ROAD
BATH TWP., ALLEN CO., OHIO

DETENTION DETAILS

DRAWN BY:	RGS
CHECKED BY:	PEL
DATE:	APRIL 2024
DWG SCALE:	AS NOTED
PROJECT NO:	324-682
APPROVED BY:	JHR

*HAND SIGNATURE ON FILE

DRAWING NO.: C800

SHEET 7 OF 11

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ALLEN COUNTY BOARD OF COMMISSIONERS
PARCEL NUMBER
37-2203-01-001.000

PORT AUTHORITY OF ALLEN COUNTY
PARCEL NUMBER
37-2203-01-001.001

ALLEN COUNTY BOARD OF COMMISSIONERS
PARCEL NUMBER
37-2203-01-001.000

N 89°32'01" E 498.60'

N 00°06'47" E 340.51'

N 89°54'16" E 31.19'

N 00°04'59" E 335.61'

S 00°28'31" E 675.69'

S 89°30'47" W 536.55'

ADA ROAD

EXISTING BUILDING

REGRADE AREA WITH SPOILS

EXIST. ASPHALT PAVEMENT

- PROPOSED LIMITS OF DISTURBANCE
- FS — PROPOSED FILTER SOCK
- SF — PROPOSED SILT FENCE
- PROPOSED INLET PROTECTION
- PROPOSED CONSTRUCTION EXIT
- PROPOSED CHECK DAM
- PROPOSED EROSION CONTROL BLANKET
- PROPOSED EROSION CONTROL MATTING

REFERENCE

1. EXISTING CONDITIONS PREPARED BY CIVIL & ENVIRONMENTAL CONSULTANTS, INC., DATED FEBRUARY, 2024.

*HAND SIGNATURE ON FILE

SUBMITTAL RECORD

NO	DATE	DESCRIPTION
1		

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PORT AUTHORITY OF ALLEN COUNTY
STORM WATER MANAGEMENT BASIN
3125 ADA ROAD
BATH TWP., ALLEN CO., OHIO

SITE SWPPP

DATE:	APRIL 2024	DRAWN BY:	RGS
DWG SCALE:	1" = 40'	CHECKED BY:	PEL
PROJECT NO.:			324-682
APPROVED BY:			JHR

DRAWING NO.:
C900
SHEET 8 OF 11

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SEDIMENT POLLUTANT CONTROLS (GENERAL NOTES):

1. ALL WORK SHALL BE IN ACCORDANCE WITH OHIO EPA NPDES CONSTRUCTION STORM WATER GENERAL PERMIT (NO: OHC000006). SOIL EROSION CONTROL MEASURES SHALL CONFORM WITH THE SPECIFICATIONS OF OHIO'S RAINWATER AND LAND DEVELOPMENT MANUAL BEST MANAGEMENT PRACTICES (BMP) AND ALLEN COUNTY.
2. AN SWP3 IS REQUIRED FOR ALL PROJECTS THAT DISTURB 1 ACRE OR MORE AND MUST BE MAINTAINED ON SITE AT ALL TIMES DURING CONSTRUCTION ACTIVITIES.
3. A NOTICE OF INTENT (NOI) APPLICATION MUST BE FILED WITH THE OHIO EPA FOR ALL PROJECTS THAT DISTURB 1 ACRE OR MORE AT LEAST 21 DAYS PRIOR TO THE START OF ANY CONSTRUCTION ACTIVITY.
   A. ALL 'OPERATORS' MUST OBTAIN PERMIT COVERAGE BEFORE BREAKING GROUND. THIS INCLUDES CONTRACTORS ASSOCIATED WITH AND RESPONSIBLE FOR THE SOIL EROSION ACTIVITIES.
   B. THESE OPERATORS' (CONTRACTORS) MUST FILE A CO-PERMITTEE NOI FORM WITH THE OHIO EPA PRIOR TO THE START OF CONSTRUCTION.
4. PERIMETER SEDIMENT CONTROLS (I.E. SEDIMENT TRAPS, SILT FENCE, COMPOST SOCKS, COMPOST BERMS, ETC.) SHALL BE IMPLEMENTED AS THE FIRST STEP OF GRADING AND WITHIN SEVEN DAYS FROM THE START OF GRUBBING AND SHALL CONTINUE TO FUNCTION UNTIL UPSLOPE AREAS DRAINING TO THEM ARE PERMANENTLY STABILIZED, OR AS DIRECTED BY ALLEN COUNTY, OR DESIGNATED REPRESENTATIVE.
5. SEDIMENT SETTLING PONDS (WHEN REQUIRED) SHALL BE INSTALLED AS THE FIRST STEP OF GRADING AND WITHIN 7 DAYS FROM THE START OF GRADING.
6. TEMPORARY INLET PROTECTION SHALL BE PROVIDED AND MAINTAINED THROUGHOUT THE DURATION OF CONSTRUCTION FOR ALL CATCH BASINS ON SITE.
   A. ONCE FINAL STABILIZATION IS ACCOMPLISHED, THE DEVELOPER/OWNER SHALL REMOVE THE INLET PROTECTION DEVICES AND HYDRAULICALLY CLEAN THE STORM SEWERS TO THE SATISFACTION OF ALLEN COUNTY AND THE PUBLIC WORKS SUPERINTENDENT. ALL SEDIMENT SHALL BE REMOVED FROM THE SYSTEM AND SHALL NOT BE FLUSHED DOWNSTREAM.
7. SHEET FLOW RUNOFF FROM DENUDED AREAS SHALL BE INTERCEPTED BY SEDIMENT BARRIERS.
8. STRUCTURAL PRACTICES SHALL BE USED TO CONTROL EROSION AND TRAP SEDIMENT FROM A SITE REMAINING DISTURBED FOR MORE THAN 14 DAYS.
9. CONCENTRATED STORM RUNOFF FROM DISTURBED AREAS FLOWING AT RATES WHICH EXCEED THE DESIGN CAPACITY OF SEDIMENT BARRIERS MUST PASS THROUGH A SEDIMENT SETTLING POND.
10. CONSTRUCTION OPERATIONS SHALL BE SCHEDULED AND PERFORMED SO THAT PREVENTIVE SOIL EROSION CONTROL MEASURES ARE IN PLACE PRIOR TO EXCAVATION IN CRITICAL AREAS AND TEMPORARY STABILIZATION MEASURES ARE IN PLACE IMMEDIATELY FOLLOWING BACKFILLING OPERATIONS.
11. SPECIAL PRECAUTIONS WILL BE TAKEN IN THE USE OF CONSTRUCTION EQUIPMENT TO PREVENT OPERATIONS WHICH PROMOTE EROSION.
12. CLEANUP WILL BE CONDUCTED IN A MANNER TO ENSURE THAT EROSION CONTROL MEASURES ARE NOT DISTURBED.
13. ALL DISTURBED AREAS THAT WILL BE LEFT IDLE OVER THE WINTER SHALL BE TEMPORARILY STABILIZED.
14. IF THE DEVELOPMENT AREA WILL, OR IS PLANNED TO REMAIN, ACTIVE THROUGH THE WINTER MONTHS, THE OWNER OF THE DEVELOPMENT AREA SHALL HOLD A PRE-WINTER STABILIZATION MEETING BEFORE OCTOBER 1ST. THE OWNER SHALL INVITE THE OPERATOR, DEVELOPER, ENGINEER, CONTRACTOR AND ANYONE ELSE REQUESTED BY ALLEN COUNTY TO THE MEETING.
15. NO EROSION AND SEDIMENT CONTROL BMP'S SHALL BE REMOVED FROM THE SITE PRIOR TO ADEQUATE PERMANENT STABILIZATION OF THE ASSOCIATED UPLAND DRAINAGE AREAS AND WITHOUT FIRST OBTAINING AUTHORIZATION FROM ALLEN COUNTY, OR HIS DESIGNATED REPRESENTATIVE, UNLESS THEIR REMOVAL IS SPECIFICALLY PROVIDED FOR WITHIN THE SITE'S APPROVED PLAN.
16. ALL TEMPORARY SOIL EROSION AND SEDIMENT CONTROL PRACTICES SHALL BE DISPOSED OF IMMEDIATELY AFTER FINAL SITE STABILIZATION IS ACHIEVED OR AFTER THE TEMPORARY PRACTICES ARE NO LONGER NEEDED, UNLESS OTHERWISE REQUIRED BY ALLEN COUNTY. TRAPPED SEDIMENT SHALL BE PERMANENTLY STABILIZED TO PREVENT FURTHER EROSION.
17. TRENCHES SHALL REMAIN OPEN FOR NO MORE THAN FIVE DAYS. THERE SHALL BE NO SEDIMENT-LADEN OR TURBID DISCHARGES TO WATER RESOURCES OR WETLANDS RESULTING FROM DEWATERING ACTIVITIES. IF TRENCH OR GROUNDWATER CONTAINS SEDIMENT, IT MUST PASS THROUGH A SEDIMENT TRAP OR OTHER EQUALLY EFFECTIVE SEDIMENT CONTROL DEVICE, PRIOR TO BEING DISCHARGED FROM THE CONSTRUCTION SITE. ALTERNATIVELY, SEDIMENT MAY BE REMOVED BY SETTLING IN PLACE OR BY DEWATERING INTO A SUMP PIT, FILTER BAG OR COMPARABLE PRACTICE. GROUND WATER DEWATERING WHICH DOES NOT CONTAIN SEDIMENT OR OTHER POLLUTANTS IS NOT REQUIRED TO BE TREATED PRIOR TO DISCHARGE. HOWEVER, CARE MUST BE TAKEN WHEN DISCHARGING GROUND WATER TO ENSURE THAT IT DOES NOT BECOME POLLUTANT-LADEN BY TRAVERSING OVER DISTURBED SOILS OR OTHER POLLUTANT SOURCES.
18. STREETS DIRECTLY ADJACENT TO CONSTRUCTION ENTRANCES AND RECEIVING TRAFFIC FROM THE DEVELOPMENT AREA, SHALL BE CLEANED DAILY TO REMOVE SEDIMENT TRACKED OFF-SITE. IF APPLICABLE, THE CATCH BASINS ON THESE STREETS NEAREST TO THE CONSTRUCTION ENTRANCES SHALL ALSO BE CLEANED WEEKLY. BASED ON SITE CONDITIONS, ALLEN COUNTY, OR HIS DESIGNATED REPRESENTATIVE, MAY REQUIRE ADDITIONAL BEST MANAGEMENT PRACTICES TO CONTROL OFF-SITE TRACKING OF DUST.
19. IT SHALL BE THE RESPONSIBILITY OF THE DEVELOPER, OR REPRESENTATIVE, TO INSPECT ALL CONTROLS ON THE SITE AT LEAST ONCE EVERY SEVEN CALENDAR DAYS, AND WITHIN 24 HOURS AFTER ANY STORM EVENT GREATER THAN ONE-HALF INCH OF RAIN PER 24 HOUR PERIOD. WHEN INSPECTIONS REVEAL THE NEED FOR REPAIR, REPLACEMENT, OR INSTALLATION OF EROSION AND SEDIMENT CONTROL BMP'S, THE FOLLOWING PROCEDURES SHALL BE FOLLOWED:
   A. WHEN PRACTICES REQUIRE REPAIR OR MAINTENANCE: THE BMP SHALL BE REPAIRED WITHIN 3 DAYS OF INSPECTION. EXCEPTION: SEDIMENT PONDS SHALL BE REPAIRED OR MAINTAINED WITH 10 DAYS OF INSPECTION.
   B. WHEN PRACTICES FAIL TO PROVIDE THEIR INTENDED FUNCTION: A MORE APPROPRIATE BMP SHALL BE SELECTED AND IMPLEMENTED WITHIN 10 DAYS OF THE INSPECTION.
   C. THE SWP3 SHALL BE UPDATED TO REFLECT THE NEW BMP'S
   D. LOCATIONS WHERE VEHICLES ENTER OR EXIT THE SITE SHALL BE INSPECTED FOR EVIDENCE OF OFF-SITE VEHICLE TRACKING.
   E. WHEN PRACTICES DEPICTED IN THE SWP3 ARE NOT INSTALLED: THE BMP SHALL BE INSTALLED WITHIN 10 DAYS OF THE INSPECTION. IF THE INSPECTION REVEALS THAT THE BMP IS NOT NECESSARY, THE RECORD MUST CONTAIN AN EXPLANATION FOR THE DECISION.
20. THE APPLICANT SHALL MAINTAIN FOR 3 YEARS FOLLOWING FINAL STABILIZATION, THE RESULTS OF THESE INSPECTIONS, THE NAMES AND QUALIFICATIONS OF PERSONNEL MAKING THE INSPECTIONS, THE DATES OF INSPECTIONS, WEATHER CONDITIONS, MAJOR OBSERVATIONS RELATING TO THE IMPLEMENTATION OF THE SWP3, A CERTIFICATION AS TO WHETHER THE FACILITY IS IN COMPLIANCE WITH THE SWP3, AND INFORMATION ON ANY INCIDENTS OF NON-COMPLIANCE DETERMINED BY THESE INSPECTIONS.
   A. THE INSPECTION LOG WILL INCLUDE THE DATE AND ACTIONS TAKEN TO CORRECT PROBLEMS NOTED IN PAST INSPECTION LOGS.
   B. IF THE CONSTRUCTION SITE IS SUBJECT TO OHIO EPA'S NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT FOR CONSTRUCTION ACTIVITY, A COPY OF ALL THE REQUIRED INSPECTION SHEETS WILL BE SUBMITTED TO ALLEN COUNTY WITHIN THREE (3) WORKING DAYS OF THE DATE THAT THE INSPECTION WAS CONDUCTED.
21. ALL EROSION AND SEDIMENT CONTROL PRACTICES SPECIFIED ON THIS PLAN SHALL CONFORM WITH THE DETAILS AND SPECIFICATIONS OUTLINED IN THE CURRENT VERSION OF THE OHIO DEPARTMENT OF NATURAL RESOURCES, "RAINWATER AND LAND DEVELOPMENT" MANUAL, OR AS SPECIFIED BY ALLEN COUNTY, OR DESIGNATED REPRESENTATIVE.
22. EROSION AND SEDIMENT CONTROL PRACTICES NOT ALREADY SPECIFIED ON THIS PLAN MAY BE NECESSARY DUE TO UNFORESEEN ENVIRONMENTAL CONDITIONS AND/OR CHANGES IN DRAINAGE PATTERNS CAUSED BY EARTH-MOVING ACTIVITY. ADDITIONAL PRACTICES SHALL BE IMPLEMENTED AT THE DEVELOPER'S EXPENSE AS DIRECTED BY ALLEN COUNTY, OR DESIGNATED REPRESENTATIVE.
23. NO STRUCTURAL SEDIMENT CONTROLS (SILT FENCE, SEDIMENT TRAPS, ETC.) SHALL BE USED IN A WATER RESOURCE OR WETLAND, UNLESS THEIR USE IS SPECIFICALLY PROVIDED FOR WITHIN THE SITE'S APPROVED PLAN.
24. SOIL STOCKPILES, TOPSOIL OR OTHERWISE, SHALL BE SITUATED AWAY FROM STREETS, SWALES, OR OTHER WATERWAYS AND SHALL BE SEEDED AND/OR MULCHED IMMEDIATELY.
25. ON-SITE PERSONNEL SHALL TAKE ALL NECESSARY MEASURES TO COMPLY WITH APPLICABLE REGULATIONS REGARDING FUGITIVE DUST EMISSIONS, INCLUDING OBTAINING NECESSARY PERMITS FOR SUCH EMISSIONS. ALLEN COUNTY, OR DESIGNATED REPRESENTATIVE, MAY REQUIRE DUST CONTROLS INCLUDING, BUT NOT LIMITED TO, THE USE OF WATER TRUCKS TO WET DISTURBED AREAS, TAPPING STOCKPILES, TEMPORARY STABILIZATION OF DISTURBED AREAS, AND REGULATION OF THE SPEED OF VEHICLES ON THE SITE.
26. ANY DISTURBED AREA NOT PAVED, SODDED, OR BUILT UPON SHALL HAVE A MINIMUM OF 80% UNIFORM VEGETATIVE COVER PRIOR TO FINAL INSPECTION AND, IN THE OPINION OF ALLEN COUNTY OR DESIGNATED REPRESENTATIVE, WILL BE MATURE ENOUGH TO CONTROL EROSION SATISFACTORILY AND SURVIVE SEVERE WEATHER.
27. A NOTICE OF TERMINATION (NOT) SHALL BE SUBMITTED WITHIN 45 DAYS OF COMPLETING ALL LAND DISTURBANCE ACTIVITIES.
28. THE APPROVED SITE GRADING AND DRAINAGE MAY NOT BE CHANGED WITHOUT THE AUTHORIZATION OF ALLEN COUNTY ENGINEERING DEPARTMENT

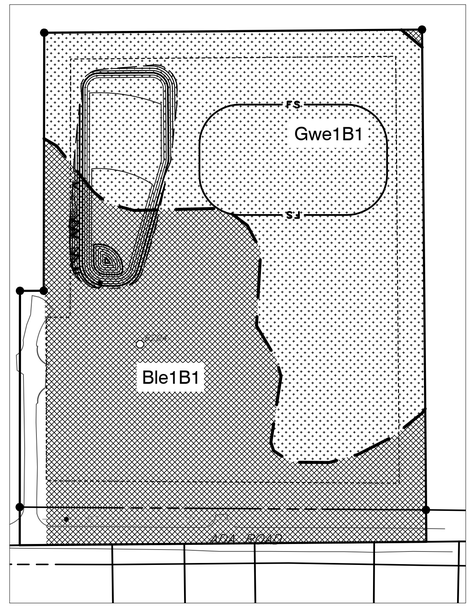
STORMWATER POLLUTION PREVENTION PLAN (SWP3) NOTES (CONTINUED)

1. OFFSITE VEHICLE TRACKING: A STABILIZED CONSTRUCTION ENTRANCE HAS BEEN PROVIDED TO HELP REDUCE VEHICLE TRACKING OF SEDIMENTS. THE PAVED STREET ADJACENT TO THE SITE ENTRANCE WILL BE MAINTAINED TO REMOVE ANY EXCESS MUD, DIRT OR ROCK TRACKED FROM THE SITE. DUMP TRUCKS HAULING MATERIAL FROM THE CONSTRUCTION SITE WILL BE COVERED WITH A TARPAULIN
2. MAINTENANCE/INSPECTION PROCEDURE
   a. EROSION AND SEDIMENT CONTROL INSPECTION AND MAINTENANCE PRACTICES: THE CONTRACTOR WILL PERFORM AND DOCUMENT THE FOLLOWING MAINTENANCE AND INSPECTION PROCEDURES:
   b. LESS THAN ONE HALF OF THE SITE WILL BE DENUDED AT ONE TIME
   c. ONLY QUALIFIED INSPECTION PERSONNEL WILL PERFORM THE INSPECTION
   d. ALL CONTROL MEASURES WILL BE INSPECTED AT LEAST ONCE EACH WEEK AND WITHIN 24 HOURS AFTER EVERY STORM EVENT OF 0.5 INCHES OR GREATER WITHIN A 24 HOUR PERIOD.
   e. ALL MEASURES WILL BE MAINTAINED IN GOOD WORKING ORDER; IF REPAIR IS NECESSARY, IT WILL BE INITIATED WITHIN 24 HOURS OF REPORT.
   f. BUILT UP SEDIMENT WILL BE REMOVED FROM SILT FENCE WHEN IT HAS REACHED ONE-THIRD THE HEIGHT OF THE FENCE.
   g. SILT FENCE WILL BE INSPECTED FOR DEPTH OF SEDIMENT, TEARS, TO SEE IF THE FABRIC IS SECURELY ATTACHED TO THE FENCE POSTS, AND TO SEE THAT THE FENCE POSTS ARE FIRMLY IN THE GROUND.
   h. NON SEDIMENT POND BMP'S WILL BE REPAIRED WITHIN 3 DAYS OF INSPECTION AND SEDIMENT PONDS SHALL BE REPAIRED OR CLEANED OUT WITHIN 10 DAYS OF INSPECTION
   i. BMP'S NOT MEETING THE INTENDED FUNCTION SHALL BE REPLACED WITHIN 10 DAYS OF THE INSPECTION.
   j. MISSING BMP'S REQUIRED FOR THE INSTALLATION OF THE SWP3 SHALL BE INSTALLED WITHIN 10 DAYS OF THE INSPECTION.
   k. BUILT UP SEDIMENT IN THE DRAINAGE SWALES WILL BE REMOVED.
   l. TEMPORARY AND PERMANENT SEEDING AND PLANTING WILL BE INSPECTED FOR BARE SPOTS, WASHOUTS, AND HEALTHY GROWTH.
   m. A MAINTENANCE INSPECTION REPORT WILL BE MADE AFTER EACH INSPECTION.
   n. THE CONTRACTOR WILL BE RESPONSIBLE FOR INSPECTING AND COMPLETING NEEDED REPAIRS, SUPERVISING SUCH REPAIRS AND FILLING OUT THE INSPECTION AND MAINTENANCE REPORT.
   o. THE INSPECTION AND MAINTENANCE REPORT WILL BE SIGNED BY THE QUALIFIED INSPECTION PERSONNEL AFTER EACH INSPECTION
   p. MISSING OR NON-FUNCTIONAL BMP'S WILL BE INSTALLED OR CORRECTED WITHIN 10 DAYS OF THE INSPECTION.
   q. THE PERMITTEE SHALL MAINTAIN FOR THREE YEARS FOLLOWING THE SUBMITTAL OF A NOTICE OF TERMINATION FORM, A COPY OF THE INSPECTION RECORDS.
9. SPILL CONTROL PRACTICES
   a. MANUFACTURERS' RECOMMENDED METHODS FOR SPILL CLEANUP WILL BE CLEARLY POSTED AND SITE PERSONNEL WILL BE MADE WARE OF THE PROCEDURES AND THE LOCATION OF THE INFORMATION AND CLEANUP SUPPLIES.
   b. MATERIALS AND EQUIPMENT NECESSARY FOR SPILL CLEANUP WILL BE KEPT IN THE MATERIAL STORAGE AREA ONSITE. EQUIPMENT AND MATERIALS WILL INCLUDE BUT NOT LIMITED TO BROOMS, DUST PANS, MOPS, RAGS, GLOVES, GOGGLES, KITTY LITTER, SAND, SAWDUST, AND PLASTIC AND METAL TRASH CONTAINERS SPECIFICALLY FOR THIS PURPOSE.
   c. ALL SPILLS WILL BE CLEANED UP IMMEDIATELY AFTER DISCOVERY.
   d. THE SPILL AREA WILL BE KEPT WELL VENTILATED AND PERSONNEL WILL WEAR APPROPRIATE PROTECTIVE CLOTHING TO PREVENT INJURY FROM CONTACT WITH A HAZARDOUS SUBSTANCE.
   e. SPILLS OF TOXIC OR HAZARDOUS MATERIAL WILL BE REPORTED TO THE APPROPRIATE STATE OR LOCAL GOVERNMENT AGENCY, REGARDLESS OF THE SIZE.
   f. THE SPILL PREVENTION PLAN WILL BE ADJUSTED TO INCLUDE MEASURES TO PREVENT THIS TYPE OF SPILL FROM REOCCURRING AND HOW TO CLEAN UP THE SPILL IF THERE IS ANOTHER ONE. A DESCRIPTION OF THE SPILL, WHAT CAUSED IT, AND THE CLEANUP MEASURES WILL ALSO BE INCLUDED.
   g. THE SITE SUPERINTENDENT RESPONSIBLE FOR THE DAY-TO-DAY SITE OPERATIONS, WILL BE THE SPILL PREVENTION AND CLEANUP COORDINATOR. HE WILL DESIGNATE AT LEAST THREE OTHER SITE PERSONNEL WHO WILL RECEIVE SPILL PREVENTION AND CLEANUP TRAINING. THESE INDIVIDUALS WILL EACH BECOME RESPONSIBLE FOR A PARTICULAR PHASE OF PREVENTION AND CLEANUP. THE NAMES OF RESPONSIBLE SPILL PERSONNEL WILL BE POSTED IN THE MATERIAL STORAGE AREA AND IN THE OFFICE TRAILER ONSITE.
10. GOOD HOUSEKEEPING
    a. AN EFFORT WILL BE MADE TO STORE ONLY ENOUGH PRODUCT REQUIRED TO DO THE JOB.
    b. ALL MATERIALS STORED ONSITE WILL BE STORED IN A NEAT, ORDERLY MANNER IN THEIR APPROPRIATE CONTAINERS AND, IF POSSIBLE, UNDER A ROOF OR OTHER ENCLOSURE.
    c. PRODUCT WILL BE KEPT IN THEIR ORIGINAL CONTAINERS WITH THE ORIGINAL MANUFACTURER'S LABEL.
    d. SUBSTANCES WILL NOT BE MIXED WITH ONE ANOTHER UNLESS RECOMMENDED BY THE MANUFACTURER.
    e. WHENEVER POSSIBLE, ALL OF A PRODUCT WILL BE USED UP BEFORE DISPOSING OF THE CONTAINER.
    f. MANUFACTURERS' RECOMMENDATIONS FOR PROPER USE AND DISPOSAL WILL BE FOLLOWED.
    g. THE SITE SUPERINTENDENT WILL INSPECT DAILY TO ENSURE PROPER USE AND DISPOSAL OF MATERIALS ONSITE.
11. CONTRACTOR SHALL UPDATE THE STORMWATER POLLUTION PREVENTION PLAN AS NECESSARY AND KEEP RECORD OF THE CHANGES ON THE SWP3 AMENDMENT LOG.
    a. CONTRACTOR SHALL UPDATE THE SWP3 TO DESIGNATE AREAS USED FOR MIXING OR STORAGE OF COMPOUNDS SUCH AS FERTILIZERS, LIME, ASPHALT, OR CONCRETE. THESE AREAS MUST BE LOCATED AWAY FROM WATERCOURSES, DRAINAGE DITCHES, FIELD DRAINS, OR OTHER STORM WATER DRAINAGE AREAS.
    b. CONTRACTOR SHALL UPDATE THE SWP3 TO DESIGNATE AREAS USED FOR FUELING OR PERFORMING VEHICLE MAINTENANCE. THESE AREAS MUST BE LOCATED AWAY FROM WATERCOURSES, DRAINAGE DITCHES, FIELD DRAINS, OR OTHER STORM WATER DRAINAGE AREAS.
    c. CONTRACTOR SHALL PROVIDE A SPILL PREVENTION CONTROL AND COUNTERMEASURES (SPCC) FOR SITES WITH ONE ABOVE GROUND STORAGE TANK (AST) OF 660 GALLONS OR MORE, TOTAL ABOVE GROUND TANK STORAGE OF 1330 GALLONS, OR BELOW GROUND STORAGE OF 42,000 GALLONS OF FUEL.

STORMWATER POLLUTION PREVENTION PLAN (SWP3) NOTES

1. SITE INFORMATION
   A. SITE ACTIVITY - THIS DEVELOPMENT CONSISTS OF THE CONSTRUCTION OF A NEW WATER QUALITY DRY DETENTION BASIN, OUTLET STRUCTURE AND METER PIPE.
   B. EXISTING SOILS - EXISTING SOILS CONSIST OF APPROXIMATELY 7 TO 12 INCHES OF TOPSOIL ACROSS THE SITE. BELOW THE SURFICIAL MATERIALS, NATURAL SOILS WERE ENCOUNTERED CONSISTING OF PREDOMINANTLY GRANULAR SOILS WITH INTERMITTENT CLAY SEAMS AND LAYERS. THE NATURAL GRANULAR SOILS WERE GENERALLY DESCRIBED AS SILT WITH SAND, POORLY GRADED SAND WITH SILT, SILTY SAND, SILT, POORLY GRADED SAND, AND SANDY SILT (USCS ML, SP-SM, SM, AND SP). THE NATURAL COHESIVE SOILS WERE GENERALLY DESCRIBED AS LEAN CLAY WITH SAND, SILTY CLAY, AND LEAN CLAY WITH SILT (USCS CL, CL-ML)
   C. RUNOFF WATERS FOR THE SITE ARE COLLECTED AND FLOW TO THE ROADSIDE STORM SEWER, WHICH FLOWS TO LIMA RESERVOIR.
2. SITE LOCATION, LATITUDE: 40°45'36.68"N LONGITUDE: 84°02'48.88"W
3. SITE DESCRIPTION - DETENTION BASIN
   A. TOTAL PROPERTY AREA = 8.027 ACRES
   B. EXISTING SITE
      - SITE AREA = 8.027 ACRES
      - TOTAL IMPERVIOUS AREA = 0.000 ACRES
   C. PRE-CONSTRUCTION RUNOFF COEFFICIENT = 0.15
   D. NEW PROPOSED DEVELOPED SITE
      - SITE AREA = 8.027 ACRES
      - TOTAL IMPERVIOUS AREA = 0.000 ACRES
   D. FINAL RUNOFF COEFFICIENT = 0.15
   E. TOTAL DISTURBED AREA = 1.53 ACRES
   F. % IMPERVIOUS AREA (OF FUTURE DEVELOPED SITE) = 70.0%
4. ORDER OF ACTIVITIES
   a. SUBMIT UPDATED NOI AS REQUIRED BY SWPPP
   b. CONTACT THE ALLEN COUNTY ENGINEER
   c. INSTALL STABILIZED CONSTRUCTION ENTRANCE AS REQUIRED
   d. INSTALL SILT FENCE AND INLET PROTECTIONS WITHIN 7 DAYS OF THE START OF GRUBBING
   e. INSTALL SEDIMENT BASIN AND FAIRCLOTH SKIMMER.
   f. INSTALL INLET PROTECTION
   g. CLEAR AND GRUB SITE FOR EXCAVATION OF STORM SEWER
   h. INSTALL STORM SEWER
   i. CONTINUE CLEARING AND GRADING SWALES
   j. STABILIZE ANY DENUDED AREAS AND STOCKPILES WITHIN 7 DAYS OF LAST CONSTRUCTION ACTIVITY IN THAT AREA (2 DAYS IF WITHIN 50' OF A BODY OF WATER)
   k. INSTALL SEDIMENT AND EROSION CONTROLS AROUND ALL CATCH BASINS AND YARD DRAINS AS BUILT
   l. COMPLETE GRADING AND INSTALL PERMANENT SEEDING AND PLANTINGS
   m. REMOVE ACCUMULATED SEDIMENT FROM SEDIMENT AND EROSION CONTROL MEASURES INSTALLED
   n. WHEN ALL CONSTRUCTION ACTIVITY IS COMPLETE AND THE SITE IS STABILIZED, REMOVE SEDIMENT AND EROSION CONTROL AND RESEED ANY AREAS DISTURBED BY THEIR REMOVAL
   o. SUBMIT NOT FOR SITE WITH OHIO EPA

5. CONTROLS
   E. CONTRACTOR RESPONSIBILITIES: THE SITE CONTRACTOR (TO BE DETERMINED) IS RESPONSIBLE FOR THE CONSTRUCTION ACTIVITIES AND FOR THE IMPLEMENTATION OF THE CONTROLS REQUIRED BY THIS SWP3. THIS CONTRACTOR AND OTHER 'OPERATORS' ARE TO SUBMIT CO-PERMITEES NOI'S.
   F. EROSION AND SEDIMENT CONTROLS: TEMPORARY AND PERMANENT STABILIZATION:
      - ALL DISTURBED AREAS THAT WILL REMAIN DORMANT FOR MORE THAN 14 DAYS MUST BE TEMPORARILY STABILIZED WITHIN 7 DAYS.
      - AREAS WITHIN 50' OF ANY STREAM THAT WILL REMAIN IDLE FOR MORE THAN 14 DAYS MUST BE TEMPORARILY STABILIZED WITHIN 2 DAYS.
      - APPLY TO DISTURBED AREAS WITHIN 7 DAYS AFTER THE FINAL GRADE IS REACHED AND FOR AREAS THAT WILL LIE DORMANT FOR ONE YEAR OR MORE.
      - FOR DISTURBED AREAS THAT WILL REMAIN IDLE OVER WINTER EROSION CONTROL MEASURES SHALL BE APPLIED PRIOR TO THE ONSET OF WINTER WEATHER.
      - FOR DISTURBED AREAS WITHIN 50 FEET FROM A STREAM REMAINING DORMANT FOR OVER 21 DAYS TEMPORARY EROSION CONTROLS SHALL BE APPLIED WITHIN 2 DAYS.
      - FOR DISTURBED AREAS OVER 50 FEET FROM A STREAM REMAINING DORMANT FOR OVER 21 DAYS TEMPORARY EROSION CONTROLS SHALL BE APPLIED WITHIN 7 DAYS.
   C. STRUCTURAL CONTROL PRACTICES
      - PERIMETER SEDIMENT BARRIERS SHALL BE IMPLEMENTED AS THE FIRST STEP OF GRADING AND WITHIN 7 DAYS FROM THE START OF GRUBBING.
      - SHEET FLOW RUNOFF FROM DENUDED AREAS SHALL BE INTERCEPTED BY SEDIMENT BARRIERS.
      - STRUCTURAL PRACTICES SHALL BE USED TO CONTROL EROSION AND TRAP SEDIMENT FROM A SITE REMAINING DISTURBED FOR MORE THAN 14 DAYS.
      - INLET PROTECTION SHALL BE PROVIDED AND MAINTAINED THROUGHOUT THE DURATION OF CONSTRUCTION FOR ALL CATCH BASINS ON SITE.
6. POST-CONSTRUCTION STORM WATER MANAGEMENT: IMPERVIOUS AREAS WILL BE REMOVED. BACKFILLED AND REGRADED AREAS, NOT DEVELOPED, WILL HAVE PERMANENT SEEDING. AREAS OF THE SITE WILL REMAIN UNTOUCHED AND IN ITS NATURAL STATE.
7. OTHER CONTROLS
   A. WASTE DISPOSAL: ALL WASTE MATERIALS WILL BE COLLECTED AND STORED IN A SECURELY LIDDED METAL DUMPSTER. ALL TRASH AND CONSTRUCTION DEBRIS FROM THE SITE WILL BE DEPOSITED IN THE DUMPSTER. THE DUMPSTER WILL BE EMPTIED AS OFTEN AS NECESSARY IN ACCORDANCE WITH STATE AND LOCAL CODES. NO CONSTRUCTION WASTE MATERIALS WILL BE BURIED ONSITE.
   B. HAZARDOUS WASTE: ALL HAZARDOUS WASTE MATERIALS WILL BE DISPOSED OF IN THE MANNER SPECIFIED BY LOCAL OR STATE REGULATION OR BY THE MANUFACTURER. SITE PERSONNEL WILL BE INSTRUCTED IN THESE PRACTICES AND THE INDIVIDUAL WHO MANAGES DAY-TO-DAY SITE OPERATIONS WILL BE RESPONSIBLE FOR SEEING THAT THESE PRACTICES ARE FOLLOWED. NO HAZARDOUS MATERIALS WILL LEAVE THE CONSTRUCTION SITE WITHOUT OWNER APPROVAL
   C. SANITARY WASTE: ALL SANITARY WASTE WILL BE COLLECTED FROM THE PORTABLE UNITS A MINIMUM OF ONE TIME A WEEK BY A LICENSED SANITARY WASTE MANAGEMENT CONTRACTOR, AS REQUIRED BY LOCAL REGULATION



EXISTING SOIL TYPES

SCALE IN FEET
0 100 200

PER USDA NRCS SOIL RESOURCE

Ble1B1 – BLOUNT SILT LOAM, END MORAINE, 2 TO 4% SLOPES

Gwe1B1 – GLYNWOOD SILT LOAM, END MORAINE, 0 TO 6% SLOPES

REFERENCE

1. EXISTING CONDITIONS PREPARED BY CIVIL & ENVIRONMENTAL CONSULTANTS, INC., DATED FEBRUARY, 2024.

*HAND SIGNATURE ON FILE

SUBMITTAL RECORD

NO	DATE	DESCRIPTION
1		

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Ph: 419.724.5281
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Civil & Environmental Consultants, Inc.

PORT AUTHORITY OF ALLEN COUNTY
STORM WATER MANAGEMENT BASIN
3125 ADA ROAD
BATH TWP., ALLEN CO., OHIO

SWPPP NOTES

DRAWN BY:		RGS
CHECKED BY:		PEL
DATE:	APRIL 2024	
DWG SCALE:	AS NOTED	
PROJECT NO:		324-682
APPROVED BY:		JHR

DRAWING NO.: C901

SHEET 9 OF 11

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TEMPORARY SEEDING

1. STRUCTURAL EROSION AND SEDIMENT CONTROL PRACTICES SUCH AS DIVERSIONS AND SEDIMENT TRAPS SHALL BE INSTALLED AND STABILIZED WITH TEMPORARY SEEDING PRIOR TO GRADING THE REST OF THE CONSTRUCTION SITE.
2. TEMPORARY SEED SHALL BE APPLIED BETWEEN CONSTRUCTION OPERATIONS ON SOIL THAT WILL NOT BE GRADED OR REWORKED FOR 21 DAYS OR GREATER. THESE IDLE AREAS SHALL BE SEEDED WITHIN 7 DAYS AFTER GRADING.
3. THE SEEDBED SHOULD BE PULVERIZED AND LOOSE TO ENSURE THE SUCCESS OF ESTABLISHING VEGETATION. TEMPORARY SEEDING SHOULD NOT BE POSTPONED IF IDEAL SEEDBED PREPARATION IS NOT POSSIBLE.
4. SOIL AMENDMENTS--TEMPORARY VEGETATION SEEDING RATES SHALL ESTABLISH ADEQUATE STANDS OF VEGETATION, WHICH MAY REQUIRE THE USE OF SOIL AMENDMENTS. BASE RATES FOR LIME AND FERTILIZER SHALL BE USED.
5. SEEDING METHOD--SEED SHALL BE APPLIED UNIFORMLY WITH A CYCLONE SPREADER, DRILL, CULTIPACKER SEEDER, OR HYDROSEEDER. WHEN FEASIBLE, SEED THAT HAS BEEN BROADCAST SHALL BE COVERED BY RAKING OR DRAGGING AND THEN LIGHTLY TAMPED INTO PLACE USING A ROLLER OR CULTIPACKER. IF HYDROSEEDING IS USED, THE SEED AND FERTILIZER WILL BE MIXED ON-SITE AND THE SEEDING SHALL BE DONE IMMEDIATELY AND WITHOUT INTERRUPTION.

MULCHING TEMPORARY SEEDING

1. APPLICATIONS OF TEMPORARY SEEDING SHALL INCLUDE MULCH, WHICH SHALL BE APPLIED DURING OR IMMEDIATELY AFTER SEEDING. SEEDINGS MADE DURING OPTIMUM SEEDING DATES ON FAVOR- ABLE, VERY FLAT SOIL CONDITIONS MAY NOT NEED MULCH TO ACHIEVE ADEQUATE STABILIZATION.
2. MATERIALS:
   - STRAW--IF STRAW IS USED, IT SHALL BE UNROTTED SMALL-GRAIN STRAW APPLIED AT A RATE OF 2 TONS PER ACRE OR 90 LBS./ 1,000 SQ. FT. (2-3 BALES)
   - HYDROSEEDERS--IF WOOD CELLULOSE FIBER IS USED, IT SHALL BE USED AT 2000 LBS./ AC. OR 46 LB./ 1,000-SQ.-FT.
   - OTHER--OTHER ACCEPTABLE MULCHES INCLUDE MULCH MATTINGS APPLIED ACCORDING TO MANUFACTURER'S RECOMMENDATIONS OR WOOD CHIPS APPLIED AT 6 TON/ AC.
3. STRAW MULCH SHALL BE ANCHORED IMMEDIATELY TO MINIMIZE LOSS BY WIND OR WATER. ANCHORING METHODS:
   - MECHANICAL--A DISK, CRIMPER, OR SIMILAR TYPE TOOL SHALL BE SET STRAIGHT TO PUNCH OR ANCHOR THE MULCH MATERIAL INTO THE SOIL. STRAW MECHANICALLY ANCHORED SHALL NOT BE FINELY CHOPPED BUT LEFT TO A LENGTH OF APPROXIMATELY 6 INCHES.
   - MULCH NETTING--NETTING SHALL BE USED ACCORDING TO THE MANUFACTURERS RECOMMENDATIONS. NETTING MAY BE NECESSARY TO HOLD MULCH IN PLACE IN AREAS OF CONCENTRATED RUNOFF AND ON CRITICAL SLOPES.
   - SYNTHETIC BINDERS--SYNTHETIC BINDERS SUCH AS ACRYLIC DLR (AGRI-TAC), DCA-70, PETROSET, TERRA TRACK OR EQUIVALENT MAY BE USED AT RATES RECOMMENDED BY THE MANUFACTURER.
   - WOOD-CELLULOSE FIBER--WOOD-CELLULOSE FIBER BINDER SHALL BE APPLIED AT A NET DRY WT. OF 750 LB./AC. THE WOOD-CELLULOSE FIBER SHALL BE MIXED WITH WATER AND THE MIXTURE SHALL CONTAIN A MAXIMUM OF 50 LB. / 100 GAL.

TEMPORARY SEEDING SPECIES SELECTION

SEEDING DATES	SPECIES	LB/1000ft²	LB/ACRE
MARCH 1 TO AUGUST 15	OATS TALL FESCUE ANNUAL RYEGRASS	3 1 1	128 40 40
	ANNUAL RYEGRASS PERENNIAL TALL FESCUE ANNUAL RYEGRASS	1 1 1	40 40 40
	ANNUAL RYEGRASS PERENNIAL RYEGRASS CREEPING RED FESCUE ANNUAL RYEGRASS	1.25 3.25 0.4 0.4	55 142 17 17
	OATS TALL FESCUE ANNUAL RYEGRASS	3 1 1	128 40 40
AUGUST 16 TO NOVEMBER 1	RYE TALL FESCUE ANNUAL RYEGRASS	3 1 1	112 40 40
	WHEAT TALL FESCUE ANNUAL RYEGRASS	3 1 1	120 40 40
	PERENNIAL RYE TALL FESCUE ANNUAL RYEGRASS	1 1 1	40 40 40
	ANNUAL RYEGRASS PERENNIAL RYEGRASS CREEPING RED FESCUE ANNUAL RYEGRASS	1.25 3.25 0.4 0.4	40 40 40 40
NOVEMBER 1 TO FEB. 29	USE MULCH ONLY OR DORMANT SEEDING		

PERMANENT SEEDING & MULCHING

SITE PREPARATION

1. SUBSOILER, PLOW, OR OTHER IMPLEMENT SHALL BE USED TO REDUCE SOIL COMPACTION AND ALLOW MAXIMUM INFILTRATION. (MAXIMIZING INFILTRATION WILL HELP CONTROL BOTH RUNOFF RATE AND WATER QUALITY.) SUBSOILING SHOULD BE DONE WHEN THE SOIL MOISTURE IS LOW ENOUGH TO ALLOW THE SOIL TO CRACK OR FRACTURE. SUBSOILING SHALL NOT BE DONE ON SLIP-PRONE AREAS WHERE SOIL PREPARATION SHOULD BE LIMITED TO WHAT IS NECESSARY FOR ESTABLISHING VEGETATION.
2. THE SITE SHALL BE GRADED AS NEEDED TO PERMIT THE USE OF CONVENTIONAL EQUIPMENT FOR SEEDBED PREPARATION AND SEEDING.
3. TOPSOIL SHALL BE APPLIED WHERE NEEDED TO ESTABLISH VEGETATION.

SEEDBED PREPARATION

1. LIME--AGRICULTURAL GROUND LIMESTONE SHALL BE APPLIED TO ACID SOIL AS RECOMMENDED BY A SOIL TEST. IN LIEU OF A SOIL TEST, LIME SHALL BE APPLIED AT THE RATE OF 100 POUNDS PER 1,000-SQ. FT. OR 2 TONS PER ACRE.
2. FERTILIZER--FERTILIZER SHALL BE APPLIED AS RECOMMENDED BY A SOIL TEST. IN PLACE OF A SOIL TEST, FERTILIZER SHALL BE APPLIED AT A RATE OF 25 POUNDS PER 1,000-SQ. FT. OR 1000 POUNDS PER ACRE OF A 10-10-10 OR 12-12-12 ANALYSES.
3. THE LIME AND FERTILIZER SHALL BE WORKED INTO THE SOIL WITH A DISK HARROW, SPRING-TOOTH HARROW, OR OTHER SUITABLE FIELD IMPLEMENT TO A DEPTH OF 3 INCHES. ON SLOPING LAND, THE SOIL SHALL BE WORKED ON THE CONTOUR.

SEEDING DATES AND SOIL CONDITIONS

SEEDING SHOULD BE DONE MARCH 1 TO MAY 31 OR AUGUST 1TO SEPTEMBER 30. IF SEEDING OCCURS OUTSIDE OF THE ABOVE- SPECIFIED DATES, ADDITIONAL MULCH AND IRRIGATION MAY BE REQUIRED TO ENSURE A MINIMUM OF 80% GERMINATION. TILLAGE FOR SEEDBED PREPARATION SHOULD BE DONE WHEN THE SOIL IS DRY ENOUGH TO CRUMBLE AND NOT FORM RIBBONS WHEN COMPRESSED BY HAND. FOR WINTER SEEDING, SEE THE FOLLOWING SECTION ON DORMANT SEEDING.

DORMANT SEEDINGS

1. SEEDINGS SHOULD NOT BE MADE FROM OCTOBER 1 THROUGH NOVEMBER 20. DURING THIS PERIOD, THE SEEDS ARE LIKELY TO GERMINATE BUT PROBABLY WILL NOT BE ABLE TO SURVIVE THE WINTER.
2. THE FOLLOWING METHODS MAY BE USED FOR 'DORMANT SEEDING':
   - FROM OCTOBER 1 THROUGH NOVEMBER 20, PREPARE THE SEEDBED, ADD THE REQUIRED AMOUNTS OF LIME AND FERTILIZER, THEN MULCH AND ANCHOR. AFTER NOVEMBER 20, AND BEFORE MARCH 15, BROADCAST THE SELECTED SEED MIXTURE. INCREASE THE SEEDING RATES BY 50% FOR THIS TYPE OF SEEDING.
   - FROM NOVEMBER 20 THROUGH MARCH 15, WHEN SOIL CONDITIONS PERMIT, PREPARE THE SEEDBED, LIME AND FERTILIZE, APPLY THE SELECTED SEED MIXTURE, MULCH AND ANCHOR. INCREASE THE SEEDING RATES BY 50% FOR THIS TYPE OF SEEDING.
   - APPLY SEED UNIFORMLY WITH A CYCLONE SEEDER, DRILL, CULTIPACKER SEEDER, OR HYDRO-SEEDER (SLURRY MAY INCLUDE SEED AND FERTILIZER) ON A FIRM, MOIST SEEDBED.
   - WHERE FEASIBLE, EXCEPT WHEN A CULTIPACKER TYPE SEEDER IS USED, THE SEEDBED SHOULD BE FIRMED FOLLOWING SEEDING OPERATIONS WITH A CULTIPACKER, ROLLER, OR LIGHT DRAG. ON SLOPING LAND, SEEDING OPERATIONS SHOULD BE ON THE CONTOUR WHERE FEASIBLE.

MULCHING

1. MULCH MATERIAL SHALL BE APPLIED IMMEDIATELY AFTER SEEDING. DORMANT SEEDING SHALL BE MULCHED. 100% OF THE GROUND SURFACE SHALL BE COVERED WITH AN APPROVED MATERIAL.
2. MATERIALS
   - STRAW--IF STRAW IS USED IT SHALL BE UNROTTED SMALL-GRAIN STRAW APPLIED AT THE RATE OF 2 TONS PER ACRE OR 90 POUNDS (TWO TO THREE BALES) PER 1,000-SQ. FT. THE MULCH SHALL BE SPREAD UNIFORMLY BY HAND OR MECHANICALLY APPLIED SO THE SOIL SURFACE IS COVERED. FOR UNIFORM DISTRIBUTION OF HAND-SPREAD MULCH, DIVIDE AREA INTO APPROXIMATELY 1,000-SQ.-FT. SECTIONS AND SPREAD TWO 45-LB. BALES OF STRAW IN EACH SECTION.
   - HYDROSEEDERS--IF WOOD CELLULOSE FIBER IS USED, IT SHALL BE APPLIED AT 2,000 LB./AC. OR 46 LB./1,000 SQ. FT.
   - OTHER--OTHER ACCEPTABLE MULCHES INCLUDE ROLLED EROSION CONTROL MATTINGS OR BLANKETS APPLIED ACCORDING TO MANUFACTURER'S RECOMMENDATIONS OR WOOD CHIPS APPLIED AT 6 TONS PER ACRE.
3. STRAW AND MULCH ANCHORING METHODS

   STRAW MULCH SHALL BE ANCHORED IMMEDIATELY TO MINIMIZE LOSS BY WIND OR WATER.
   - MECHANICAL--A DISK, CRIMPER, OR SIMILAR TYPE TOOL SHALL BE SET STRAIGHT TO PUNCH OR ANCHOR THE MULCH MATERIAL INTO THE SOIL. STRAW MECHANICALLY ANCHORED SHALL NOT BE FINELY CHOPPED BUT, GENERALLY, BE LEFT LONGER THAN 6 INCHES.
   - MULCH NETTING--NETTING SHALL BE USED ACCORDING TO THE MANUFACTURER'S RECOMMENDATIONS. NETTING MAY BE NECESSARY TO HOLD MULCH IN PLACE IN AREAS OF CONCENTRATED RUNOFF AND ON CRITICAL SLOPES.
   - ASPHALT EMULSION--ASPHALT SHALL BE APPLIED AS RECOMMENDED BY THE MANUFACTURE OR AT THE RATE OF 160 GALLONS PER ACRE.
   - SYNTHETIC BINDERS--SYNTHETIC BINDERS SUCH AS ACRYLIC DLR (AGRI-TAC), DCA-70, PETROSET, TERRA TACK OR EQUIVALENT MAY BE USED AT RATES SPECIFIED BY THE MANUFACTURER.
   - WOOD CELLULOSE FIBER--WOOD CELLULOSE FIBER SHALL BE APPLIED AT A NET DRY WEIGHT OF 750 POUNDS PER ACRE. THE WOOD CELLULOSE FIBER SHALL BE MIXED WITH WATER WITH THE MIXTURE CONTAINING A MAXIMUM OF 50 POUNDS CELLULOSE PER 100 GALLONS OF WATER.

IRRIGATION

PERMANENT SEEDING SHALL INCLUDE IRRIGATION TO ESTABLISH VEGETATION DURING DRY WEATHER OR ON ADVERSE SITE CONDITIONS, WHICH REQUIRE ADEQUATE MOISTURE FOR SEED GERMINATION AND PLANT GROWTH.

IRRIGATION RATES SHALL BE MONITORED TO PREVENT EROSION AND DAM- AGE TO SEEDED AREAS FROM EXCESSIVE RUNOFF.

PERMANENT SEEDING MAINTENANCE

1. PERMANENT SEEDING SHALL NOT BE CONSIDERED ESTABLISHED FOR AT LEAST 1 FULL YEAR FROM THE TIME OF PLANTING. INSPECT THE SEEDING FOR SOIL EROSION OR PLANT LOSS DURING THIS FIRST YEAR. REPAIR BARE AND SPARSE AREAS. FILL GULLIES. RE-FERTILIZE, RE-SEED, AND RE-MULCH IF REQUIRED. CONSIDER NO-TILL PLANTING. A MINIMUM OF 70% GROWTH DENSITY, BASED ON A VISUAL INSPECTION, MUST EXIST FOR AN ADEQUATE PERMANENT VEGETATIVE PLANTING.
   - IF STAND IS INADEQUATE OR PLANT COVER IS PATCHY, IDENTIFY THE CAUSE OF FAILURE AND TAKE CORRECTIVE ACTION: CHOICE OF PLANT MATERIALS, LIME AND FERTILIZER QUANTITIES, POOR SEEDBED PREPARATION, OR WEATHER. IF VEGETATION FAILS TO GROW, HAVE THE SOIL TESTED TO DETERMINE WHETHER PH IS IN THE CORRECT RANGE OR NUTRIENT DEFICIENCY IS A PROBLEM.
   - DEPENDING ON STAND CONDITIONS, REPAIR WITH COMPLETE SEEDBED PREPARATION, THEN OVER-SEED OR RE-SEED.
   - IF IT IS THE WRONG TIME OF YEAR TO PLANT DESIRED SPECIES, OVER-SEED WITH SMALL GRAIN COVER CROP TO THICKEN THE STAND UNTIL TIMING IS RIGHT TO PLANT PERENNIALS OR USE TEMPORARY SEEDING. SEE TEMPORARY SEEDING STANDARD.
2. SATISFACTORY ESTABLISHMENT MAY REQUIRE RE-FERTILIZING THE STAND IN THE SECOND GROWING SEASON.
   - DO NOT FERTILIZE COOL SEASON GRASSES IN LATE MAY THROUGH JULY (I.E. KENTUCKY BLUEGRASS, ORCHARDGRASS, PERENNIAL RYEGRASS, SMOOTH BROME, FESCUE, TIMOTHY, REED CANARYGRASS AND GARRISON GRASS)
   - GRASS THAT LOOKS YELLOW MAY BE NITROGEN DEFICIENT. IN LIEU OF A SOIL TEST, AN APPLICATION OF 50 LBS. OF N-P-K PER ACRE IN EARLY SPRING WILL HELP COOL SEASON GRASSES COMPETE AGAINST WEEDS OR GROW MORE SUCCESSFULLY.
   - DO NOT USE NITROGEN FERTILIZER IF THE STAND CONTAINS MORE THAN 20 PERCENT LEGUMES.

LONG-TERM MAINTENANCE FERTILIZATION RATES SHALL BE ESTABLISHED BY FOLLOWING SOIL TEST RECOMMENDATIONS OR BY USING THE RATES IN THE FOLLOWING TABLE.

PERMANENT SEEDING

SEED MIX	SEEDING RATE LBS/ACRE	SEEDING RATE LBS/1000ft²	NOTES
GENERAL USE			
CREEPING RED FESCUE DOMESTIC RYEGRASS KENTUCKY BLUEGRASS	20-40 10-20 20-40	1/2 -1 1/4 - 1/2 1/2 -1	FOR CLOSE MOWING & FOR WATERWAYS WITH <2.0 FT/S VELOCITY
TALL FESCUE	40-50	1 - 1 1/4	
TURF-TYPE (DWARF)	90	2 1/4	
STEEP BANKS OR CUT SLOPES			
TALL FESCUE	40-50	1 - 1 1/4	
CROWN VETCH TALL FESCUE	10-20 20-30	1/4 - 1/2 1/2 - 3/4	DO NOT SEED LATER THAN AUGUST
FLAT PEA TALL FESCUE	20-25 20-30	1/2 - 3/4 1/2 - 3/4	DO NOT SEED LATER THAN AUGUST
ROAD DITCHES AND SWALES			
TALL FESCUE	40-50	1 - 1 1/4	
TURF-TYPE (DWARF) FESCUE KENTUCKY BLUEGRASS	90 5	2 1/4 0.1	
LAWNS			
KENTUCKY BLUEGRASS TALL FESCUE	100-120	2 2	
FLAT PEA TALL FESCUE	100-120	2 1-1/2	FOR SHADED AREAS

MAINTENANCE FOR PERMANENT SEEDINGS FERTILIZATION AND MOWING

SEED MIXTURE	FORMULA	LBS/AC	LBS/1000ft²	TIME	MOWING
CREEPING RED FESCUE DOMESTIC RYEGRASS KENTUCKY BLUEGRASS	10-10-10	500	12	FALL, YEARLY, OR AS NEEDED	NOT CLOSER THAN 3"
TALL FESCUE	10-10-10	500	12		NOT CLOSER THAN 4"
TURF-TYPE (DWARF)	90	500	12		
CROWN VETCH FESCUE	10-20	400	10	SPRING, YEARLY FOLLOWING ESTABLISHMENT AND EVERY 4-7 YEARS THEREAFTER	DO NOT MOW
FLAT PEA	0-20-20	400	10		

MULCHING

MULCH AND OTHER APPROPRIATE VEGETATIVE PRACTICES SHALL BE APPLIED TO DISTURBED AREAS WITHIN 7 DAYS OF GRADING IF THE AREA IS TO REMAIN DORMANT (UNDISTURBED) FOR MORE THAN 21 DAYS OR ON AREAS AND PORTIONS OF THE SITE WHICH CAN BE BROUGHT TO FINAL GRADE.

1. MULCH SHALL CONSIST OF ONE OF THE FOLLOWING:
   - STRAW - STRAW SHALL BE UNROTTED SMALL GRAIN STRAW APPLIED AT THE RATE OF 2 TONS/AC. OR 90 LB./1,000 SQ. FT. (TWO TO THREE BALES). THE STRAW MULCH SHALL BE SPREAD UNIFORMLY BY HAND OR MECHANICALLY SO THE SOIL SURFACE IS COVERED. FOR UNIFORM DISTRIBUTION OF HAND-SPREAD MULCH, DIVIDE AREA INTO APPROXIMATELY 1,000 SQ.FT. SECTIONS AND PLACE TWO 45-LB. BALES OF STRAW IN EACH SECTION.
   - HYDROSEEDERS - WOOD CELLULOSE FIBER SHOULD BE USED AT 2,000 LB./AC. OR 46 LB./1,000 SQ. FT.
   - OTHER - ACCEPTABLE MULCHES INCLUDE MULCH MATTINGS AND ROLLED EROSION CONTROL PRODUCTS APPLIED ACCORDING TO MANUFACTURER'S RECOMMENDATIONS OR WOOD MULCH/CHIPS APPLIED AT 10-20 TONS/AC.
2. MULCH ANCHORING - MULCH SHALL BE ANCHORED IMMEDIATELY TO MINIMIZE LOSS BY WIND OR RUNOFF. THE FOLLOWING ARE ACCEPTABLE METHODS FOR ANCHORING MULCH.
   - MECHANICAL - USE A DISK, CRIMPER, OR SIMILAR TYPE TOOL SET STRAIGHT TO PUNCH OR ANCHOR THE MULCH MATERIAL INTO THE SOIL. STRAW MECHANICALLY ANCHORED SHALL NOT BE FINELY CHOPPED BUT BE LEFT GENERALLY LONGER THAN 6 INCHES.
   - MULCH NETTINGS - USE ACCORDING TO THE MANUFACTURER'S RECOMMENDATIONS, FOLLOWING ALL PLACEMENT AND ANCHORING REQUIREMENTS. USE IN AREAS OF WATER CONCENTRATION AND STEEP SLOPES TO HOLD MULCH IN PLACE.
   - SYNTHETIC BINDERS - FOR STRAW MULCH, SYNTHETIC BINDERS SUCH AS ACRYLIC DLR (AGRI-TAC), DCA-70, PETROSET, TERRA TACK OR EQUAL MAY BE USED AT RATES RECOMMENDED BY THE MANUFACTURER. ALL APPLICATIONS OF SYNTHETIC BINDERS MUST BE CONDUCTED IN SUCH A MANNER WHERE THERE IS NO CONTACT WITH WATERS OF THE STATE.
   - WOOD CELLULOSE FIBER - WOOD CELLULOSE FIBER MAY BE USED FOR ANCHORING STRAW. THE FIBER BINDER SHALL BE APPLIED AT A NET DRY WEIGHT OF 750 LB./ACRE. THE WOOD CELLULOSE FIBER SHALL BE MIXED WITH WATER AND THE MIXTURE SHALL CONTAIN A MAXIMUM OF 50 LB./100 GAL. OF WOOD CELLULOSE FIBER.

TABLE 1: PERMANENT STABILIZATION

AREA REQUIRING PERMANENT STABILIZATION	TIME FRAME TO APPLY EROSION CONTROLS
ANY AREAS THAT WILL LIE DORMANT FOR ONE YEAR OR MORE	WITHIN SEVEN DAYS OF THE MOST RECENT DISTURBANCE
ANY AREAS WITHIN 50 FEET OF A SURFACE WATER OF THE STATE AND AT FINAL GRADE	WITHIN TWO DAYS OF REACHING FINAL GRADE
ANY OTHER AREAS AT FINAL GRADE	WITHIN SEVEN DAYS OF REACHING FINAL GRADE WITHIN THAT AREA

TABLE 2: TEMPORARY STABILIZATION

AREA REQUIRING TEMPORARY STABILIZATION	TIME FRAME TO APPLY EROSION CONTROLS
ANY AREAS WITHIN 50 FEET OF A SURFACE WATER OF THE STATE AND NOT AT FINAL GRADE	WITHIN TWO DAYS OF THE MOST RECENT DISTURBANCE IF THE AREA WILL REMAIN IDLE FOR MORE THAN 14 DAYS
FOR ALL CONSTRUCTION ACTIVITIES, ANY DISTURBED AREAS THAT WILL BE DORMANT FOR MORE THAN 14 DAYS BUT LESS THAN ONE YEAR, AND NOT WITHIN 50 FEET OF A SURFACE WATER OF THE STATE	WITHIN SEVEN DAYS OF THE MOST RECENT DISTURBANCE WITHIN THE AREA FOR RESIDENTIAL SUBDIVISIONS, DISTURBED AREAS MUST BE STABILIZED AT LEAST SEVEN DAYS PRIOR TO TRANSFER OF PERMIT COVERAGE FOR THE INDIVIDUAL LOT(S).
DISTURBED AREAS THAT WILL BE IDLE OVER WINTER	PRIOR TO THE ONSET OF WINTER WEATHER

REFERENCE

1. EXISTING CONDITIONS PREPARED BY CIVIL & ENVIRONMENTAL CONSULTANTS, INC., DATED FEBRUARY, 2024.

SUBMITTAL RECORD

NO	DATE	DESCRIPTION
1		

One SeaGate
Suite 2050
Toledo, OH 43604
Ph: 419.724.5281
www.cecinc.com

Civil & Environmental Consultants, Inc.

PORT AUTHORITY OF ALLEN COUNTY
STORM WATER MANAGEMENT BASIN
3125 ADA ROAD
BATH TWP., ALLEN CO., OHIO

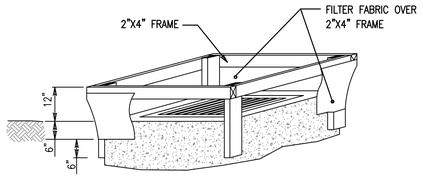
*HAND SIGNATURE ON FILE

SWPPP NOTES

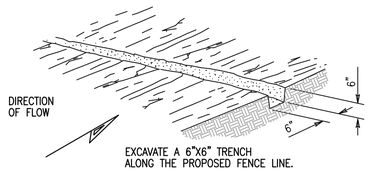
DRAWN BY:	RGS
CHECKED BY:	PEL
DATE:	APRIL 2024
DWG SCALE:	AS NOTED
PROJECT NO:	324-682
APPROVED BY:	JHR

DRAWING NO.:
C902
SHEET 10 OF 11

P:\320-000\324-682\-CAD\Dwg\CIVIL\324682-CIV1-C900.dwg[SWPPP NOTES (3)] LS(4/25/2024 - plogan) - LP: 5/20/2024 2:45 PM

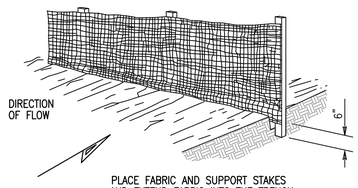


TEMPORARY INLET PROTECTION
FILTER FABRIC FENCE



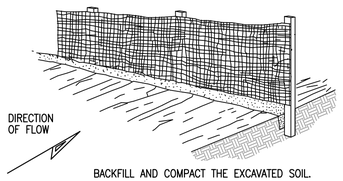
EXCAVATE A 6"X6" TRENCH
ALONG THE PROPOSED FENCE LINE.

STEP 1



PLACE FABRIC AND SUPPORT STAKES
AND EXTEND FABRIC INTO THE TRENCH.

STEP 2



BACKFILL AND COMPACT THE EXCAVATED SOIL.

STEP 3

PLACEMENT AND CONSTRUCTION OF
PERIMETER FILTER FABRIC FENCE

NOTES

MATERIALS: FILTER FABRIC SHALL MEET THE REQUIREMENTS OF CMS 712.09, TYPE C. SUPPORT STAKES SHALL BE A MINIMUM OF 1.5"X1.5", NOMINAL, AND SHALL BE HARDWOOD OF SOUND QUALITY. THE STAKES SHALL BE DRIVEN A MINIMUM OF 6" BELOW THE BOTTOM OF THE FILTER FABRIC. THE MAXIMUM SPACING BETWEEN SUPPORT STAKES SHALL BE 10'.

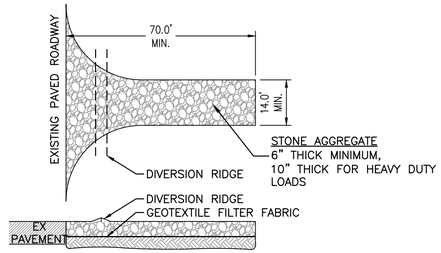
CONSTRUCTION: THE BOTTOM OF THE FABRIC SHALL BE BURIED 6" BELOW THE GROUND. THE ENDS OF ADJACENT SECTIONS OF FENCE SHALL BE OVERLAPPED WITH THE END STAKE OF EACH SECTION WRAPPED TOGETHER PRIOR TO INSTALLATION. THE GROUND ELEVATION OF THE FENCE SHALL BE HELD CONSTANT EXCEPT THAT THE END ELEVATIONS SHALL BE RAISED UPSLOPE TO PREVENT FLOW AROUND THE END OF THE FENCE.

MAINTENANCE: THE FILTER FABRIC FENCE SHALL BE MAINTAINED TO BE FUNCTIONAL. THIS SHALL INCLUDE REMOVAL OF TRAPPED SEDIMENT AND REQUIRED CLEANING, REPAIR, AND REPLACEMENT OF THE FILTER FABRIC. THE MAINTENANCE OR REPLACEMENT COST WILL BE PAID FOR BY THE DEPARTMENT UNDER UNIT BID PRICES, AGREED UNIT PRICES, OR CMS 109.04.

PAYMENT: THE COST OF ALL MATERIALS, CONSTRUCTION AND REMOVAL SHALL BE PAID FOR UNDER ITEM 207 – TEMPORARY PERIMETER FILTER FABRIC FENCE OR TEMPORARY DITCH CHECK FILTER FABRIC FENCE, LINEAR FOOT.

TYPICAL INLET PROTECTION & SILT FENCE DETAILS

SCALE = NTS



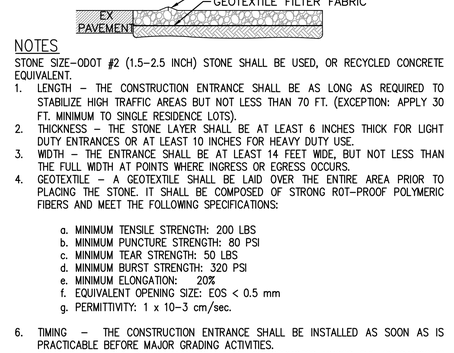
NOTES

STONE SIZE–ODOT #2 (1.5–2.5 INCH) STONE SHALL BE USED, OR RECYCLED CONCRETE EQUIVALENT.

1. LENGTH – THE CONSTRUCTION ENTRANCE SHALL BE AS LONG AS REQUIRED TO STABILIZE HIGH TRAFFIC AREAS BUT NOT LESS THAN 70 FT. (EXCEPTION: APPLY 30 FT. MINIMUM TO SINGLE RESIDENCE LOTS).
2. THICKNESS – THE STONE LAYER SHALL BE AT LEAST 6 INCHES THICK FOR LIGHT DUTY ENTRANCES OR AT LEAST 10 INCHES FOR HEAVY DUTY USE.
3. WIDTH – THE ENTRANCE SHALL BE AT LEAST 14 FEET WIDE, BUT NOT LESS THAN THE FULL WIDTH AT POINTS WHERE INGRESS OR EGRESS OCCURS.
4. GEOTEXTILE – A GEOTEXTILE SHALL BE LAID OVER THE ENTIRE AREA PRIOR TO PLACING THE STONE. IT SHALL BE COMPOSED OF STRONG ROT–PROOF POLYMERIC FIBERS AND MEET THE FOLLOWING SPECIFICATIONS:
   a. MINIMUM TENSILE STRENGTH: 200 LBS
   b. MINIMUM PUNCTURE STRENGTH: 80 PSI
   c. MINIMUM TEAR STRENGTH: 50 LBS
   d. MINIMUM BURST STRENGTH: 320 PSI
   e. MINIMUM ELONGATION: 20%
   f. EQUIVALENT OPENING SIZE: EOS < 0.5 mm
   g. PERMITTIVITY: 1 x 10–3 cm/sec.
6. TIMING – THE CONSTRUCTION ENTRANCE SHALL BE INSTALLED AS SOON AS IS PRACTICABLE BEFORE MAJOR GRADING ACTIVITIES.
7. CULVERT – A PIPE OR CULVERT SHALL BE CONSTRUCTED UNDER THE ENTRANCE IF NEEDED TO PREVENT SURFACE WATER FROM FLOWING ACROSS THE ENTRANCE OR TO PREVENT RUNOFF FROM BEING DIRECTED OUT ONTO PAVED SURFACES.
8. WATER BAR – A WATER BAR SHALL BE CONSTRUCTED AS PART OF THE CONSTRUCTION ENTRANCE IF NEEDED TO PREVENT SURFACE RUNOFF FROM FLOWING THE LENGTH OF THE CONSTRUCTION ENTRANCE AND OUT ONTO PAVED SURFACES.
9. MAINTENANCE – TOP DRESSING OF ADDITIONAL STONE SHALL BE APPLIED AS CONDITIONS DEMAND, MUD SPILLED, DROPPED, WASHED, OR TRACKED ONTO PUBLIC ROADS, OR ANY SURFACE WHERE RUNOFF IS NOT CHECKED BY SEDIMENT CONTROLS, SHALL BE REMOVED IMMEDIATELY. REMOVAL SHALL BE ACCOMPLISHED BY SCRAPING OR SWEEPING.
10. CONSTRUCTION ENTRANCES SHALL NOT BE RELIED UPON TO REMOVE MUD FROM VEHICLES AND PREVENT OFF–SITE TRACKING. VEHICLES THAT ENTER AND LEAVE THE CONSTRUCTION SITES SHALL BE RESTRICTED FROM MUDDY AREAS.
11. REMOVAL – THE ENTRANCE SHALL REMAIN IN PLACE UNTIL THE DISTURBED AREA IS STABILIZED OR REPLACED WITH A PERMANENT ROADWAY OR ENTRANCE.
12. ALL VEHICLES SHALL BE INSPECTED FOR EVIDENCE OF OFF–SITE VEHICLE TRACKING WHEN ENTERING OR EXITING THE SITE
13. IF MUD MAT BECOMES CLOGGED WITH SEDIMENT SO THAT IT NO LONGER ADEQUATELY PERFORMS ITS FUNCTION, THE STONE MUST BE CLEANED AND REPLACED
14. ALL EQUIPMENT LEAVING THE SITE MUST USE MUD MATT AND HAVE LOADS STABILIZED AND TIGHT WITH ALL LOOSE DEBRIS AND MATTER REMOVED PRIOR TO TRAVELING ON PUBLIC ROADWAYS
15. ANY TRACK–OUT NOT CONTAINED BY THE MUD MAT MUST BE CLEANED UP BY THE CONTRACTOR IMMEDIATELY AFTER OCCURRENCE NO LATER

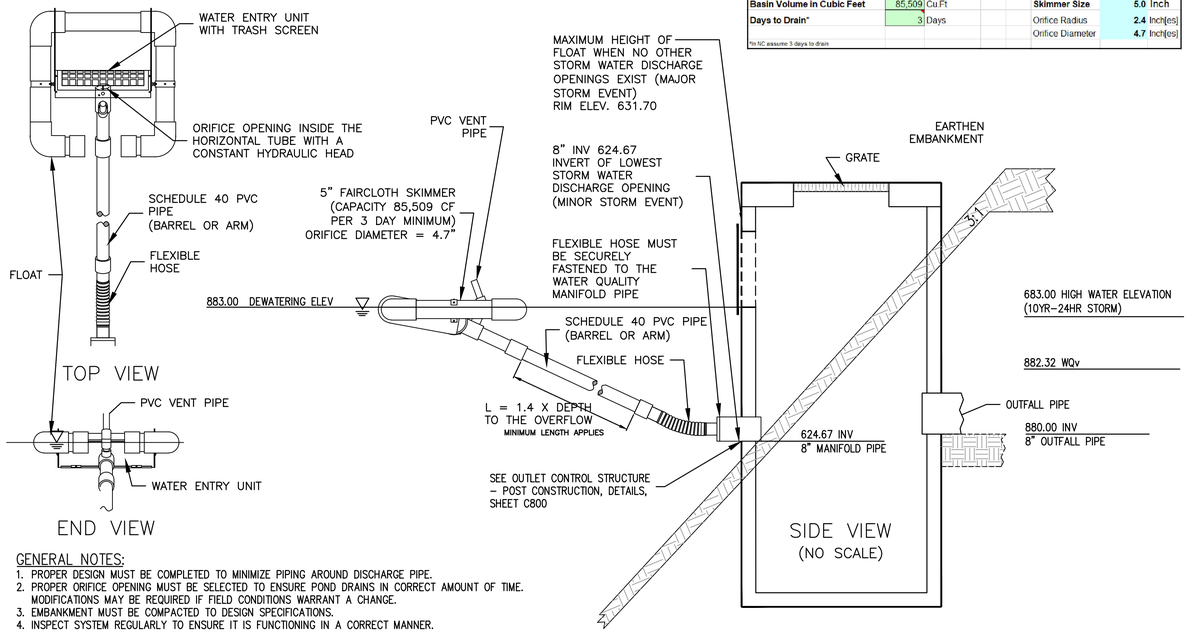
TYPICAL CONSTRUCTION ENTRANCE/EXIT DETAIL

SCALE = NTS



SILT SACK ASSEMBLY

SCALE = NTS



Calculate Skimmer Size					
Basin Volume in Cubic Feet	85,509	Cu Ft	Skimmer Size	5.0	Inch
Days to Drain*	3	Days	Orifice Radius	2.4	Inch[es]
			Orifice Diameter	4.7	Inch[es]

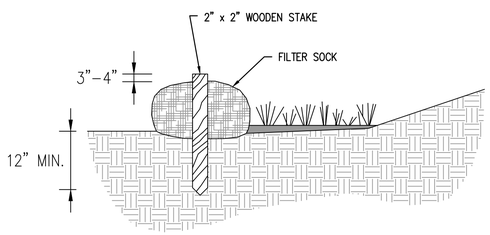
*In NC assume 3 days to drain

GENERAL NOTES:

1. PROPER DESIGN MUST BE COMPLETED TO MINIMIZE PIPING AROUND DISCHARGE PIPE.
2. PROPER ORIFICE OPENING MUST BE SELECTED TO ENSURE POND DRAINS IN CORRECT AMOUNT OF TIME. MODIFICATIONS MAY BE REQUIRED IF FIELD CONDITIONS WARRANT A CHANGE.
3. EMBANKMENT MUST BE COMPACTED TO DESIGN SPECIFICATIONS.
4. INSPECT SYSTEM REGULARLY TO ENSURE IT IS FUNCTIONING IN A CORRECT MANNER.
5. THE FAIRCLOTH SKIMMER SHALL BE REMOVED WHEN FINAL STABILIZATION IS ESTABLISHED, SEE STORMWATER POLLUTION PREVENTION PLAN (SWP3) NOTES ON SHEET CE 5–01–01

SEDIMENT BASIN - CONSTRUCTION WATER QUALITY SKIMMER DETAIL

SCALE = NTS



MATERIALS

1. MATERIALS – COMPOST USED FOR FILTER SOCKS SHALL BE WEED, PATHOGEN, INSECT FREE, AND FREE OF ANY REFUSE, CONTAMINATION, OR OTHER MATERIALS TOXIC TO PLANT GROWTH. THEY SHALL BE DERIVED FROM A WELL–DECOMPOSED SOURCE OF ORGANIC MATTER AND CONSIST OF PARTICLES RANGING FROM 3/8" TO 2".
2. FILTER SOCKS SHALL BE 3 OR 5 MIL CONTINUOUS, TUBULAR, HDPE 3/8" KNITTED MESH NETTING MATERIAL, FILLED WITH COMPOST PASSING THE ABOVE SPECIFICATIONS FOR COMPOST PRODUCTS.

INSTALLATION:

3. FILTER SOCKS WILL BE PLACED ON A LEVEL LINE ACROSS SLOPES, GENERALLY PARALLEL TO THE BASE OF THE SLOPE OF OTHER AFFECTED AREA. ON SLOPES APPROACHING 2:1, ADDITIONAL SOCKS SHALL BE PROVIDED AT THE TOP AND AS NEEDED MID–SLOPE.
4. FILTER SHOCKS INTENDED TO BE LEFT AS A PERMANENT FILTER OR PART OF THE NATURAL LANDSCAPE, SHALL BE SEEDED AT THE TIME OF INSTALLATION FOR ESTABLISHMENT OF PERMANENT VEGETATION.
5. FILTER SOCKS ARE NOT TO BE USED IN CONCENTRATED FLOW SITUATIONS OR IN RUNOFF CHANNELS.

MAINTENANCE:

6. ROUTINELY INSPECT FILTER SOCKS AFTER EACH SIGNIFICANT RAIN, MAINTAINING FILTER SOCKS IN A FUNCTIONAL CONDITION AT ALL TIMES.
7. REMOVE SEDIMENTS COLLECTED AT THE BASE OF THE FILTER SOCKS WHEN THEY REACH 1/3 OF THE EXPOSED HEIGHT OF THE PRACTICE.
8. WHERE THE FILTER SOCK DETERIORATES OF FAILS, IT WILL BE REPAIRED OR REPLACED WITH A MORE EFFECTIVE ALTERNATIVE.
9. REMOVAL – FILTER SOCKS WILL BE DISPERSED ON SITE WHEN NO LONGER REQUIRED IN SUCH A WAY AS TO FACILITATE AND NOT OBSTRUCT SEEDINGS.

FILTER SOCK DETAIL

SCALE = NTS

REFERENCE

1. EXISTING CONDITIONS PREPARED BY CIVIL & ENVIRONMENTAL CONSULTANTS, INC., DATED FEBRUARY, 2024.

SUBMITTAL RECORD

NO	DATE	DESCRIPTION

One SeaGate
Suite 2050
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Civil & Environmental Consultants, Inc.

PORT AUTHORITY OF ALLEN COUNTY
STORM WATER MANAGEMENT BASIN
3125 ADA ROAD
BATH TWP., ALLEN CO., OHIO

SWPPP DETAILS

DATE:	APRIL 2024
DWG SCALE:	AS NOTED
PROJECT NO:	324-682
DRAWN BY:	RGS
CHECKED BY:	PEL
APPROVED BY:	JHR

*HAND SIGNATURE ON FILE

DRAWING NO.:
C903
SHEET 11 OF 11

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APPENDIX C

OHIO DEPARTMENT OF TRANSPORTATION CONSTRUCTION AND MATERIAL SPECIFICATIONS

APPENDIX C-1

ODOT CMS, JANUARY 1, 2023

STATE OF OHIO

DEPARTMENT OF TRANSPORTATION COLUMBUS, OHIO

CONSTRUCTION AND MATERIAL SPECIFICATIONS

JANUARY 1, 2023

An Equal Opportunity Employer

Copies of the Construction and Material Specifications may be purchased by contacting:

Ohio Department of Transportation
Office of Contracts
P.O. Box 899
Columbus, Ohio 43216-0899
Telephone (614) 466-3778, 466-3200

Total Printed: 11,000
Unit Cost: 8.06
Publication Date: 01/2023

Table of Contents

100 GENERAL PROVISIONS

101 DEFINITIONS AND TERMS

101.01 General. These Construction and Material Specifications are written to the Bidder before award of the Contract and to the Contractor after award of the Contract. The sentences that direct the Contractor to perform Work are written as commands. For example, a requirement to provide cold-weather protection would be expressed as, "Provide cold-weather protection for concrete," rather than "The Contractor shall provide cold-weather protection for concrete." In the imperative mood, the subject "the Bidder" or "the Contractor" is understood.

All requirements to be performed by others have been written in the active voice. Sentences written in the active voice identify the party responsible for performing the action. For example, "The Engineer will determine the density of the compacted material." Certain requirements of the Contractor may also be written in the active voice, rather than the active voice and imperative mood, if the sentence includes requirements for others in addition to the Contractor. For example, "After the Contractor provides initial written notice, the Engineer will revise the Contract as specified in 104.02."

Sentences that define terms, describe a product or desired result, or describe a condition that may exist are written in indicative mood. These types of sentences use verbs requiring no action. For example, "The characteristics of the soils actually encountered in the subgrade may affect the quality of the cement and depth of treatment necessary."

101.02 Abbreviations. The following abbreviations, when used in the Contract Documents, represent the full text shown.

AAN	American Association of Nurserymen
AASHTO	American Association of State Highway and Transportation Officials
AC	Asphalt Cement (pavement), Alternating Current (traffic)
ACBFS	Air Cooled Blast Furnace Slag (aggregate)
ACI	American Concrete Institute
ACIA	Asynchronous Communications Interface Adapter (traffic controller)
ADT	Average Daily Traffic
ADTT	Average Daily Truck Traffic
AIC	Amps Interrupting Capacity
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANFO	Ammonium Nitrate and Fuel Oil
ANSI	American National Standards Institute
AOS	Apparent Opening Size (fabric)
AREA	American Railway Engineering Association
AMRL	AASHTO Material Reference Library
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects

ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
AWPA	American Wood Preservers' Association
AWS	American Welding Society
AWWA	American Water Works Association
BBR	Bending Beam Rheometer (asphalt binder test)
BMP	Best Management Practice (erosion)
BOF	Basic Oxygen Furnace (aggregate)
BSG	Bulk Specific Gravity
BTEX	Benzene, toluene, ethyl benzene, and xylene (a soil test)
BUSTR	Bureau of Underground Storage Tank Regulations (Division of Fire Marshal)
C&MS	Construction and Material Specifications
CAPWAP	Case Pile Wave Analysis Program
CBAE	Cut Back Asphalt Emulsion
CCRL	Cement and Concrete Reference Laboratory
CCS	Crushed Carbonate Stone
CECI	Contactors Erosion Control Inspector
CFR	Code of Federal Regulations
CIE	Commission Internationale d'Eclairage (illumination)
CPESC	Certified Professional in Erosion and Sediment Control
CRS	Cationic Rapid Set (asphalt emulsion)
CRSI	Concrete Reinforcing Steel Institute
CSS	Cationic Slow Set (asphalt emulsion)
CVN	Charpy V-notch (steel test)
CWT	Hundred Weight (100 lbs)
DC	Direct Current
DCA	District Construction Administrator
DCE	District Construction Engineer
DDD	District Deputy Director
DET	District Engineer of Tests
DGE	District Geotechnical Engineer
DLS	Data Logging System (traffic markings)
DNR	Department of Natural Resources
DRC	Dry Rodded Condition (asphalt aggregate test)
DSR	Dynamic Shear Rheometer (asphalt binder test)
DZA	Deficient Zone Average (concrete test)
EAF	Electric Arc Furnace
EDA	Earth Disturbing Activity
EEI	Edison Electric Institute
EIA	Electronic Industries Alliance
EPA	Environmental Protection Agency
EQS	Exceptional Quality Solids (compost)
FAA	Fine Aggregate Angularity (asphalt aggregate)
FCM	Fracture Critical Member (steel test)
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration, Department of Transportation

FRP	Fiber Reinforced Polymer
FSS	Federal Specifications and Standards, General Services Administration
GGBFS	Ground Granulated Blast Furnace Slag
GS	Granulated Slag
HDPE	High Density Polyethylene
HMWM	High Molecular Weight Methacrylate
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronic Engineers
IES	Illuminating Engineering Society
IMSA	International Municipal Signal Association
IPCEA	Insulated Power Cable Engineers Association
IPS	International Pipe Standard
ISSA	International Slurry Seal Association
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System
IZEU	Inorganic Zinc Epoxy Urethane
JMF	Job Mix Formula
LED	Light Emitting Diode
LWT	Loaded Wheel Test (asphalt test)
MBF	Thousand Board Feet (wood)
MC	Medium Cure (asphalt emulsion)
MCB	Microchannel Bus (traffic controller)
MOV	Metal Oxide Varistor (traffic controller)
MPI	Magnetic Particle Inspection (steel test)
MSG	Maximum Specific Gravity (asphalt)
MTD	Maximum Theoretical Density (asphalt)
NACE	National Association of Corrosion Engineers
NCHRP	National Cooperative Highway Research Program
NEMA	National Electrical Manufacturers Association
NHI	National Highway Institute
NIST	National Institute of Standards and Technology
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
OAC	Ohio Administrative Code
ODOT	Ohio Department of Transportation
OEPA	Ohio Environmental Protection Agency
OH	Open Hearth (aggregate)
OHWM	Ordinary High Water Mark
OMM	Office of Materials Management (the Central Office Laboratory)
OMUTCD	Ohio Manual of Uniform Traffic Control Devices
ORC	Ohio Revised Code
ORDC	Ohio Rail Development Commission
OSHA	Occupational Safety and Health Administration
OTO	Office of Traffic Operations
OWPCA	Ohio Water Pollution Control Act
OZEU	Organic Zinc Epoxy Urethane
PAT	Project Average Thickness (concrete test)

PAV	Pressure Aging Vessel (asphalt binder test)
PB	Polybutylene (conduit)
PCC	Portland Cement Concrete
PCS	Petroleum Contaminated Soil
PDA	Pile Dynamic Analysis (steel piling)
PE	Polyethylene (conduit)
PG	Performance Grade (asphalt binder grading system)
pH	Potential of Hydrogen
PLS	Pure Live Seed
PVC	Polyvinyl chloride
QA	Quality Assurance
QC	Quality Control
QCFS	Quality Control Fabricator Specialist (structures)
QCP	Quality Control Program, or Plan, or Points (steel test)
QPL	Qualified Products List
RAP	Reclaimed Asphalt Pavement
RAS	Reclaimed Asphalt Shingles
RC	Rapid Cure (asphalt emulsion)
REA	Rural Electrification Act
RFI	Radio Frequency Interference (traffic controller)
RH	Relative Humidity
RMS	Root Mean Square (traffic controller)
RPCC	Recycled Portland Cement Concrete
RPM	Raised Pavement Marker (traffic)
RS	Rapid Set (asphalt emulsion)
RTFO	Rolling Thin-Film Oven (asphalt binder test)
RUS	Rural Utilities Service
SAE	Society of Automotive Engineers
SBA	Styrene Butadiene Amine
SBR	Styrene Butadiene Rubber
SBS	Styrene Butadiene Styrene
SCD	Standard Construction Drawing
SDS	Safety Data Sheets
SF	Standard Fabricated members (structures)
SI	International System of Units (Metric)
SM	AASHTOWare Project Sitemanager ™
SMA	Stone Matrix Asphalt
SPD	Surge Protection Device (traffic controller)
SPST	Single Pole / Single Throw (traffic controller)
SS	Slow Set (asphalt emulsion)
SSD	Saturated Surface Dry (aggregate)
SSPC	Society for Protective Coatings
SWPPP	Storm Water Pollution Prevention Plan
TAP	Traffic Authorized Product
TCE	Trichloroethylene
TMPTA	Tri-methyolpropane Tri-acrylate (paint)
TNP	Total Neutralizing Power
TODS	Tourist-Oriented Directional Signs

TSEC	Temporary Sediment and Erosion Control
TSR	Tensile Strength Ratio (asphalt mix test)
UF	Unique Fabricated members (structures)
UL	Underwriters' Laboratories, Inc.
USACE	United States Army Corps of Engineers
USC	United States Code
VA	Verification Acceptance
VAC	Volts Alternating Current
VCA	Volume of Coarse Aggregate (asphalt mix test)
VECP	Value Engineering Change Proposal
VMA	Voids in the Mineral Aggregate
VME	VersaModule Eurocard (traffic controller)
WDT	Watchdog Timer
WEAP	Wave Equation Analysis (steel piling)
WPS	Welding Procedure Specification (steel test)
WZRPM	Work Zone Raised Pavement Marker (traffic)
XCU	Explosion, Collapse and Underground

101.03 Definitions. The following terms or pronouns, when used in the Contract Documents, are defined as follows:

Advertisement. The public announcement, as required by law, inviting Bids for Work to be performed or materials to be furnished.

Award. The written acceptance by the Director of a Bid.

Bid. The offer of a Bidder, on the prescribed form properly signed and guaranteed, to perform the Work and to furnish the labor and materials at the prices quoted.

Bid Documents. The Bid Documents include the Invitation for Bids, Addenda, Proposal, Expedite file, contract form and required bonds, Specifications, Supplemental Specifications, Special Provisions, general and detailed plans, Plan notes, standard construction drawings identified in the Plans, notice to Contractor, and any other document designated by the Department as a Bid Document, all of which constitute one instrument.

Bidder. An individual, firm, or corporation submitting a Bid for the advertised Work, acting directly or through the duly authorized representative, and qualified as provided in ORC 5525.02 to 5525.09.

Bridge. A structure, including supports, erected over a depression or an obstruction, such as water, a highway, or a railway, and having a track or passageway for carrying traffic or other moving loads and having a length measured along the center of roadway of 10 feet (3.048 m) or more between undercopings of abutments or extreme limits of openings for multiple boxes.

A. Length. The length of a bridge structure is the over-all length measured along the centerline of the roadway surface.

B. Roadway Width. The clear width measured at right angles to the longitudinal centerline of the bridge between the bottom of curbs or guard timbers or, in the case of multiple heights of curbs, between the bottoms of the lower risers. For curb widths of 1 foot (0.3 m) or less, the roadway width is measured between parapets or railings.

Calendar Day or Day. Every day shown on the calendar.

Certified Test Data. A test report from a manufacturer or an independent laboratory approved by the Director listing actual test results of samples tested for compliance with specified Department requirements. The Department will accept certified test data from manufacturers' laboratories if their products have been used satisfactorily on prior Department contracts and their test data has been confirmed. Include a statement that the test data furnished is representative of the material furnished to a Department project or to a supplier. The report is identified by number or date and identifies the Department project or supplier to which the material is shipped. Submit reports signed by a person having legal authority to act for the manufacturer or independent laboratory.

Change Order. A written order issued by the Director to the Contractor, covering changes to the terms and conditions, plans and/or quantities, within or beyond the scope of the Contract and establishing the basis of payment and time adjustments for the work affected by the changes.

Claims. Disputes that are not settled through Steps 1 and 2 of the Dispute Resolution and Administrative Claim Process. The Dispute becomes a Claim when the Contractor submits a Notice of Intent to File a Claim.

Completion Date. The date, as shown in the Contract Documents, on which the Work contemplated shall be completed.

Construction Limits. These limits must encompass all Work. This includes removals, room for construction equipment to complete work, site access, etc.

Contract. The written agreement between the Department and the Contractor setting forth the obligations of the parties, including, but not limited to, the performance of the Work and the basis of payment.

Contract Bond. The approved forms of security, executed by the Contractor and its Sureties, guaranteeing complete execution of the Work as required by the Contract Documents and the payment of all legal debts pertaining to the construction of the Project which security shall comply with and be subject to ORC 5525.16 and 5525.13, and related provisions.

Contract Documents. The Contract Documents include the Invitation for Bids, Addenda, Proposal, contract form and required bonds, Specifications, Supplemental Specifications, Special Provisions, general and detailed plans, Plan notes, standard construction drawings identified in the Plans, notice to contractor, Change Orders, Supplemental Agreements, Extra Work Contracts, "Accepted" and "Accepted as Noted" Working Drawings, and any other document designated by the Department as a Contract Document, all of which constitute one instrument.

Contract Item (Pay Item). A specifically described unit of Work for which a price is provided in the Contract.

Contract Price. The amount of compensation bid by the Contractor for a Contract Item in the Proposal or the amount of compensation established for a Contract Item added or modified pursuant to the Contract Documents.

Contract Time. The number of workdays or calendar days, including authorized adjustments, allowed for completion of the Project. When a specified Completion Date is shown in the Contract Documents instead of the number of workdays or calendar days, completion of the Project shall occur on or before that date. Specified Completion Date and Calendar Day Contracts shall be completed on or before the day indicated even when that date is a Saturday, Sunday, or holiday.

Contractor. The individual, firm, or corporation contracting with the Department for performance of prescribed Work, acting directly or through a duly authorized representative and qualified under the provisions of ORC 5525.02 to 5525.09 inclusive, and any amendments thereto.

County. The designated county in which the Work specified is to be done.

Culvert. Any structure not classified as a Bridge that provides an opening under the roadway.

Department. The Department of Transportation, State of Ohio.

Director. Administrative head of the Department appointed by the Governor.

Disputes. Disagreements, matters in question and differences of opinion between the Department's personnel and the Contractor.

District Testing. The Departments district testing laboratories.

Engineer. Duly authorized agent of the Department acting within the scope of its authority for purposes of engineering and administration of the Contract. In managing the administration of the contract, the Engineer may confer with representatives of Industry including, but not limited to, the designer of record, landscape architects, environmental specialists, etc.

Engineered Drawings. A type of Working Drawing that requires the practice of engineering as defined in ORC 4733.01(E). Examples of Engineered Drawings include: Excavation Bracing Plans, Demolition Plans, Erection Plans, Falsework Plans, Cofferdam Plans, Causeway Plans, Jacking and Temporary Support Plans, Plans for Heavy Equipment on Structures, Plans for structures for Maintaining Traffic, and Corrective Work Plans.

Equipment. All machinery and equipment, together with the necessary supplies for upkeep and maintenance, and also tools and apparatus necessary for the proper construction and acceptable completion of the Work.

Extra Work. An item of Work not provided for in the Contract as awarded but found essential to the satisfactory completion of the Contract within its intended scope.

Extra Work Contract. A Contract concerning the performance of Work or furnishing of materials involving Extra Work. Such Extra Work may be performed at agreed prices or on a force account basis as provided in ORC 5525.14.

Fabricator. The individual, firm, or corporation that fabricates structural metals or prestressed concrete members as an agent of the Contractor.

Final Inspector. An Engineer appointed by the DDD who inspects the completed Work and accepts it if it complies with the Contract Documents.

Inspector. The Engineer's authorized representative assigned to make detailed inspections of Contract performance.

Invitation for Bids. The invitation for Proposals for all Work on which Bids are required. Such Proposal will indicate with reasonable accuracy the quantity and location of the Work to be done or the character and quality of the material to be furnished and the time and place of the opening of Proposals.

Laboratory. The testing laboratories of the Department, including the Office of Materials Management (OMM) located at 1600 West Broad Street, Columbus, Ohio, and the District testing facilities.

Materials. Any materials or products specified for use in the construction of the Project and its appurtenances.

Partnering. A collaborative process for project cooperation and communication meant to achieve effective and efficient contract performance and completion of the Project within budget, on schedule, safely and with requisite quality in accordance with the contract.

Plans. The drawings, standard construction drawings and supplemental drawings provided by the Department that show the location, character, dimensions, and details of the Work.

Prebid Question. A written inquiry submitted by a prospective bidder.

Professional Landscape Architect. A landscape architect registered with the Ohio Landscape Architects Board to practice landscape architecture in the State of Ohio.

Profile Grade. The trace of a vertical plane intersecting the top surface of the proposed wearing surface, usually along the longitudinal centerline of the roadbed. Profile grade means either elevation or gradient of such trace according to the context.

Project Limits. Project limits are points on the mainline centerline of construction where the proposed improvement, as described in the project description on the Title Sheet (excluding incidental construction), begins and ends

Project Right-of-Way. That portion of the Right-of-Way between the beginning and end of the Project.

Project. The specific section of the highway together with all appurtenances and Work to be performed thereon under the Contract.

Proposal. The approved form on which the Department requires Bids to be prepared and submitted for the Work.

Proposal Guaranty. The security furnished with a Bid to guarantee that the Bidder will enter into the Contract if its Bid is accepted.

Questionnaire. The specified forms on which the Contractor shall furnish required information as to its ability to perform and finance the Work required under ORC 5525.01.

Reasonably Close Conformity. Reasonably close conformity means compliance with reasonable and customary manufacturing and construction tolerances where working tolerances are not specified. Where working tolerances are specified, reasonably close conformity means compliance with such working tolerances. Without detracting from the complete and absolute discretion of the Engineer to insist upon such tolerances as establishing reasonably close conformity, the Engineer may accept variations beyond such tolerances as reasonably close conformity where they will not materially affect the value or utility of the Work and the interests of the Department.

Registered Engineer. An engineer registered with the Ohio State Board of Registration for Professional Engineers and Surveyors to practice professional engineering in the State of Ohio

Registered Surveyor. A surveyor registered with the Ohio State Board of Registration for Professional Engineers and Surveyors to practice professional surveying in the State of Ohio.

Right-of-Way. A general term denoting land, property, or interest therein, usually in a strip, acquired for or devoted to a highway.

Road. A general term denoting a public way for purposes of vehicular travel, including the entire area within the Right-of-Way, as defined in ORC 5501.01.

Roadbed. The graded portion of a highway within top and side slopes, prepared as a foundation for the pavement structure and shoulder.

Roadside. The areas between the outside edges of the shoulders and the Right-of-Way boundaries. Unpaved median areas between inside shoulders of divided highways and infield areas of interchanges are included.

Roadside Development. Those items necessary to the highway that provide for the preservation of landscape materials and features; the rehabilitation and protection against erosion of all areas disturbed by construction through seeding, sodding, mulching, and the placing of other ground covers; such suitable planting; and other improvements as may increase the effectiveness and enhance the appearance of the highway.

Roadway. The portion of a highway within limits of construction.

Shop Drawings. Drawings accepted by the Contractor and submitted to the Department that describe portions of the Work fabricated off site that are incorporated permanently with the project. Department acceptance is not required.

Shoulder. The portion of the roadway contiguous to the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

Sidewalk. That portion of the roadway primarily constructed for the use of pedestrians.

Signatures on Contract Documents. All signatures on Contract Documents must meet the requirements of 102.06.

Special Provisions. Additions and revisions to the standard and Supplemental Specifications covering conditions peculiar to an individual Project.

Specifications. The directions, provisions, and requirements contained herein as supplemented by the Supplemental Specifications and Special Provisions.

State. The State of Ohio acting through its authorized representative.

Street. A general term denoting a public way for purpose of vehicular travel, including the entire area within the Right-of-Way.

Structures. Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, endwalls, buildings, sewers, service pipes, underdrains, foundation drains, and other features that may be encountered in the Work and not otherwise classed herein.

Subcontractor. An individual, firm, or corporation to whom the Contractor sublets part of the Contract to be performed on the job site, who prior to such undertaking receives the written consent of the Director, and who is qualified under ORC 5525.02 through 5525.09 inclusive.

Subgrade. The portion of a Roadbed upon which the pavement structure and shoulders are constructed.

Substructure. All of that part of the structure below the bearings of simple and continuous spans, skewbacks of arches, and tops of footings of rigid frames, together with backwalls and wings.

Superintendent. The Contractor's authorized representative in responsible charge of the Work.

Superstructure. The entire structure except the Substructure.

Supplement. A list of requirements for fabrication plants, methods of test, or other miscellaneous requirements that are maintained on file in the Office of the Director.

Supplemental Agreement. A written agreement executed by the Contractor and by the Director covering necessary alterations.

Supplemental Specifications. Detailed specifications supplemental to or superseding these Specifications.

Surety. The corporation, partnership, or individual, other than the Contractor, executing a bond furnished by the Contractor.

Titles (or Headings). The titles or headings of the sections and subsections herein are intended for convenience of reference and shall not be considered as having any bearing on their interpretation.

Waters of the United States. Waters that are under the jurisdiction of the Corps of Engineers under the Clean Water Act as defined by 33 CFR Ch. II Part 328, which as applied to Ohio means: the Ohio River and Lake Erie and any other river, stream, creek, lake, pond, or wetland that drains directly or indirectly into the Ohio River or Lake Erie.

Work. All labor, materials, equipment, tools, transportation, supplies, and other incidentals and all tasks that comprise the project or any portion thereof, as described by the Contract Documents.

Work Limits. Work Limits are the extreme limits of the contractor's responsibility on a project, including all temporary and incidental construction, with the exception of work zone traffic control devices required for maintenance of traffic.

Workday. A calendar day that the Contractor normally works.

Working Drawings. Contractor submitted drawings for work, not otherwise defined in the Bid Documents, and require Department acceptance. Examples of Working Drawings include: Engineered Drawings, installation plans, certified drawings, and any other supplementary plans or similar data that the Contractor is required to submit for acceptance.

101.04 Interpretations. In order to avoid cumbersome and confusing repetition of expressions in these Specifications, it is provided that whenever anything is, or is to be, done, if, as, or, when, or where "contemplated, required, determined, directed, specified, authorized, ordered, given, designated, indicated, considered necessary, deemed necessary, permitted, reserved, suspended, established, approval, approved, disapproved, acceptable, unacceptable, suitable, accepted, satisfactory, unsatisfactory, sufficient, insufficient, rejected, or condemned," it shall be understood as if the expression were followed by the words "by the Engineer" or "to the Engineer."

102 BIDDING REQUIREMENTS AND CONDITIONS

102.01 Prequalification of Bidders. A Bidder must be prequalified by the Department according to ORC Chapter 5525 and the rules and regulations governing prequalification in order to submit a Bid. Upon request, the Department will provide a prequalification application, applicable rules and regulations, and other relevant information. For prospective Bidders that are not yet prequalified, furnish the Department with a properly completed prequalification application at least 30 days before the date specified for the receipt of Bids. The prequalification certificate is the Bidder's license to Bid and perform construction for the Department.

For foreign Contractors, refer to ORC 5525.18 and Ohio Administrative Rule 5501:2-3-07.

The Department will perform contractor performance evaluations for each contractor and subcontractor on every ODOT-let construction project. Evaluations shall be well documented, objective, and performed in a timely manner, in accordance with Supplement 1131. The contractor's average scores for the previous calendar year will be used in the calculation of the contractor's bidding capacity. The contractor has the right to appeal an evaluation.

102.02 Contents of Bid Documents. Use the Proposal to prepare and submit Bids for the Work. Upon request, the Department will provide Bid Documents that include or reference the following:

A. Location and description of the Project.

B. Estimate of quantities and description of the Work.

C. Time to complete the Work.

D. Amount of the Proposal Guaranty.

E. Department's deadline for receiving a completed Bid.

F. Schedule of contract items.

G. Standard Specifications, Special Provisions, Supplemental Specifications, and the Plans.

H. Proposal.

102.03 Issuance of Proposals.

A. General. Upon request, the Department will provide applicable rates and other relevant information for obtaining bidding information and submitting a Bid.

B. Department Will Not Issue. The Department may refuse to sell or issue Bid Documents to a prospective Bidder for any of the following reasons:

1. The prospective Bidder owes the Department for previously issued plans.

2. The prospective Bidder has defaulted on previous contracts.

3. The prospective Bidder is debarred from bidding on and receiving Department contracts.

4. The prospective Bidder is currently in the debarment process.

102.04 Interpretation of Quantities in Proposal. The quantities in the Bid Documents are approximate and the Department uses them for the comparison of Bids only.

The Department will only pay the Contractor for the actual quantities of Work performed and accepted according to the Contract Documents. The Department may increase, decrease, or omit the scheduled quantities of Work as provided in 109.04 without invalidating the Bid prices.

102.05 Examination of Bid Documents and Project Site and Submission of Prebid Questions. Carefully examine the Bid Documents and perform a reasonable site investigation before submitting a Bid. Submitting a Bid is an affirmative statement that the Bidder has investigated the Project site and is satisfied as to the character, quality, quantities, and the conditions to be encountered in performing the Work. A reasonable site investigation includes investigating the Project site, borrow sites, hauling routes, and all other locations related to the performance of the Work.

When available, the Department will include in the Contract Documents or provide for the Bidder's review at the Department's offices or website, one or more of the following:

A. Record drawings.

B. Available information relative to subsurface exploration, borings, soundings, water levels, elevations, or profiles.

C. The results of other preliminary investigations.

A reasonable site investigation includes a review of these documents.

Should a question arise at any time during the examination of Bid Documents or investigation of the site the Bidder may seek clarification by submitting a Prebid Question. Submit all Prebid Questions in writing via the Department's website. The Department will post a response on its website to all questions submitted before a deadline of 10:00 am four working days prior to the public opening of Bids. Responses to Prebid Questions posted on the Department's website are not revisions to the Bidding Documents and are not binding. The Department is not obligated to respond to, or otherwise act upon, a Prebid Question submitted after this deadline, but reserves the right to act upon any information received.

102.06 Preparation of Bids. Prepare a Bid according to this subsection and the requirements found in the Bid Documents. Properly complete the Expedite file and submit it using the software specified in the Bid Documents rather than completing it by handwriting, typing, or using unauthorized computer-generated forms.

Provide a unit price for each item listed in the Proposal. Calculate and place the products for the respective unit prices and quantities in the "Bid Amount" column. For a lump sum item, place the same price in the "Unit Price" column and in the "Bid Amount" column pertaining to that item. Indicate the total Bid amount by adding the values entered in the "Bid Amount" column for the listed items. Submit the Expedite file using the software specified in the Bid Documents.

Properly execute the Proposal by completing the miscellaneous section and attaching the required signatures in the space provided in the Expedite file.

ENTITY SUBMITTING PROPOSAL
REQUIRED SIGNATURE

Individual	The individual or a duly authorized agent.
Partnership	A partner or a duly authorized agent.
Joint Venture	A member or a duly authorized agent of at least one of the joint venture firms.
Corporation	An authorized officer or duly authorized agent of the corporation. Also, show the name of the state chartering the corporation and affix the corporate seal.
Limited Liability Company	A manager, a member, or a duly authorized agent.

102.07 Duty to Notify of Errors in Bid Documents. Notify the Department of errors and omissions in the Bid Documents. Make notification by submitting a question in the manner described in 102.05. The Contractor's duty to disclose errors and omissions is not only a bidding requirement but is also a legal requirement that cannot be ignored.

Failure to provide the required notification prior to the opening of bids shall constitute a waiver by the Contractor and does not obligate the Department for any costs based upon any apparent or patent ambiguity arising from insufficient data or obvious errors in the Bid documents. Knowingly withholding information regarding an error or omission in the Bid Documents, or intentionally misrepresenting an item

of Work for financial or competitive gain may result in civil or criminal penalties in excess of the value of the item bid.

102.08 Unbalanced Bidding. Bid all items correctly and price each quantity as indicated in the Bid Documents. The Department will reject a Mathematically Unbalanced Bid if the Bid is also Materially Unbalanced. A Mathematically Unbalanced Bid is a Bid containing lump sum or unit price items that do not include reasonable labor, equipment, and material costs plus a reasonable proportionate share of the Bidder's overhead costs, other indirect costs, and anticipated profit. A Materially Unbalanced Bid is when the Department determines that an award to the Bidder submitting a Mathematically Unbalanced Bid will not result in the lowest ultimate cost to the Department.

102.09 Proposal Guaranty. The Department will reject a Bid submitted without a Proposal Guaranty in the amount designated and payable to the Director. Submit the required Proposal Guaranty in one of the following forms:

A. Properly executed project Bid bond submitted on the Department's form.

B. Properly executed electronic bid transfer to the Department's account.

C. Certified check drawn on the account of the Bidder submitting the Bid.

D. Cashier's check.

E. Properly executed electronic project Bid bond submitted using the software specified in the Bid Documents.

When submitting a Bid bond, ensure that the Surety is licensed to do business in the State.

If the Department invites alternate Bids and the Bidder elects to Bid more than one alternate, the Bidder may submit one Proposal Guaranty in the amount required for a single alternate. The Proposal Guaranty covers each individual Bid.

If the Department invites combined Bids and the Bidder elects to Bid only on one package, then the Bidder must submit only one Proposal Guaranty. If the Bidder bids on the combined Bid package, the Bidder must submit a Proposal Guaranty in the amount required for the combined Bid. The combined Proposal Guaranty covers each individual Bid.

102.10 Delivery of Bid. Unless otherwise indicated in the Proposal, all Bids must be submitted using the electronic Bid submission software specified in the Proposal. The Department will accept Bids until the time and date designated in the Notice to Bidders. The Department will return Bids received after the designated time to the Bidders unopened. The Department will return all Bids not prepared and submitted in accordance with the Proposal.

102.11 Withdrawal of Bids. After Bids are opened, ORC 5525.01 requires that a Bidder identify a mistake in its Bid within 48 hours of the Bid opening. After Bids are opened the Bidder must provide a written request to withdraw a Bid already filed with the Department. Any Bidder for whom a request to withdraw its Bid is approved by the Department will not be permitted to participate in any manner in a contract awarded for that project for which the Bid was withdrawn.

102.12 Combination Proposals. The Department may elect to issue Bid Documents for projects in combination or separately, so that Bids may be submitted either on the combination or on separate units of the combination. The Department reserves the right to make awards on combination Bids or separate Bids to the best advantage of the Department. The Department will not consider combination Bids, other than those it specifically identifies in the Bid Documents. The Department will write separate Contracts for each individual Project included in the combination.

102.13 Public Opening of Bids. The Department will publicly open Bids at the time and place indicated in the notice to Contractors. The Department will announce the total Bid amount for each Bid.

Bidders or their authorized agent and other interested persons are invited to the opening.

The Department may postpone the receipt of Bid time or the opening of Bids time. If the Department changes the hour or the date of the receipt of Bids or the opening of Bids, it will issue an addendum or public notice to notify prospective Bidders.

102.14 Disqualification of Bidders. The Department will declare a Bid non-responsive and ineligible for award when any of the following occur:

A. The Bidder lacks sufficient prequalification work types or dollars to be eligible for award.

B. The Bidder fails to furnish the required Proposal Guaranty in the proper form and amount.

C. The Bid contains unauthorized alterations or omissions.

D. The Bid contains conditions or qualifications not provided for in the Bid Documents.

E. The Proposal is not prepared as specified.

F. A single entity, under the same name or different names, or affiliated entities submits more than one Bid for the same Project.

G. The Bidder fails to submit a unit price for each contract item listed, except for lump sum items where the Bidder may show a price in the “Bid Amount” column for that item.

H. The Bidder fails to submit a lump sum price where required.

I. The Bidder fails to submit a complete Expedite file using the software specified in the Proposal.

J. The Bidder is debarred from submitting Bids.

K. The Bidder has defaulted, has had a Contract terminated for cause by the Department, has either agreed not to Bid or has had debarment proceedings initiated against the Bidder’s company and/or its key personnel.

L. The Bidder submits its Bid or Proposal Guaranty on forms other than those provided by the Department.

M. The Bidder fails to properly complete the supplemental questionnaire section of the Expedite file.

N. The Bidder submits a Materially Unbalanced Bid as defined by 102.08.

O. The Bidder fails to acknowledge addenda.

P. The Department finds evidence of collusion.

Q. Any other omission, error, or act that, in the judgment of the Department, renders the Bidder's bid non-responsive.

102.15 Material Guaranty. Before any Contract is awarded, the Department may require the Bidder to furnish a complete statement of the origin, composition, and manufacture of any or all Materials to be used in the construction of the Work together with samples. The Department may test the samples as specified in these Specifications to determine their quality and fitness for the Work.

102.16 Certificate of Compliance with Affirmative Action Programs. Before any Contract is awarded, the Department will require the Bidder to furnish a valid Certificate of Compliance with Affirmative Action Programs, issued by the State EEO Coordinator.

102.17 Drug-Free Safety Program. During the life of this project, the Contractor and all its Subcontractors, that provide labor on the Project site, must be enrolled in and remain in good standing in the Ohio Bureau of Worker's Compensation ("OBWC") Drug-Free Safety Program ("DFSP") or a comparable program approved by the OBWC.

In addition to being enrolled in and in good standing in an OBWC-approved DFSP or a comparable program approved by the OBWC, the Department requires each Contractor and Subcontractor that provides labor, to subject its employees who perform labor on the project site to random drug testing of 5 percent of its employees. The random drug testing percentage must also include the on-site supervisors of the Contractors and Subcontractors. Upon request, the Contractor and Subcontractor shall provide evidence of required testing to the Department.

Each Subcontractor shall require all lower-tier Subcontractors that provides labor on the project site with whom the Subcontractor is in contract for the Work to be enrolled in and be in good standing in the OBWC-approved DFSP prior to a lower-tier Subcontractor providing labor at the Site.

The Department will declare a bid non-responsive and ineligible for award if the Contractor is not enrolled and in good standing in the Ohio Bureau of Workers' Compensation's Drug-Free Safety Program (DFSP) Discount Program or a similar program approved by the Bureau of Workers' Compensation within 8 days of the bid opening. Furthermore, the Department will deny all requests to sublet when the subcontractor does not comply with the provisions of this section.

Failure of the Contractor to require a Subcontractor to be enrolled in and be in good standing in the an OBWC-approved DFSP prior to the time that the Subcontractor provides labor at the Site, shall result in the Contractor being found in breach of the Contract and that breach shall be used in the responsibility analysis

of that Contractor or the Subcontractor who was not enrolled in a program for future contracts with the State for five years after the date of the breach.

103 AWARD AND EXECUTION OF CONTRACT

103.01 Consideration of Proposals. After opening and announcing the Bids, the Department will compare the Bidders' proposed prices. The proposed price is the summation of the products of the estimated quantities shown in the Proposal and the unit Bid prices. If the amount shown for the proposed product differs from the actual product of the unit Bid price and the estimated quantity, then the actual product will govern.

The Department may reject any or all Bids, waive technicalities, or advertise for new Bids without liability to the Department.

103.02 Award of Contract. The Department will award a Contract or reject Bids within 10 days after Bid opening. The Department will mail a letter to the address on the Bid notifying the successful Bidder of Bid acceptance and Contract award. The Department will award to the lowest competent and responsible bidder. The Department will not award a Contract until it completes an investigation of the apparent low Bidder.

If the Department's estimate for the cost of the improvement is not confidential, the Department will not award a Contract for an amount greater than 5 percent more than the Department's estimate. If the Department's estimate is confidential, the Department may award the Contract according to ORC 5525.15.

103.03 Cancellation of Award. The Department may cancel a Contract award at any time before all parties sign the Contract without liability to the Department.

103.04 Return of Proposal Guaranty. Immediately after the opening and checking of Bids, the Department will return all Proposal Guaranties provided in the form of a certified check or cashier's check, except to the three lowest Bidders. Within 10 days after opening bids, the Department will return the Proposal Guaranties of the two remaining unsuccessful Bidders. After the successful Bidder submits the signed Contract, Contract Bonds, and other Contract Documents, and after the Department signs the Contract, the Department will return the Proposal Guaranty to the successful Bidder. The Department will not return Bid bonds.

103.05 Requirement of Contract Bond. Furnish Contract Bonds within 10 days after receiving notice of award. Furnish Contract Bonds to the Director on the prescribed form, in the amount of the Contract, and according to ORC 5525.16.

103.06 Execution of Contract. Sign and return the Contract, along with the certificate of compliance, Contract Bonds, and other required Contract Documents, within 10 days after notice of award. The State does not consider a proposal binding until the Director signs the Contract. If the Director does not sign the Contract within 20 days after receiving the successful Bidder's signed Contract, certificates, Contract Bonds, and other Contract Documents, the successful Bidder may withdraw the Bid without prejudice.

103.07 Failure to Execute Contract. If the successful Bidder fails to sign the Contract and furnish the Contract Bonds, the Department will have just cause to cancel the award. The successful Bidder shall forfeit the Proposal Guaranty to the Department, not as a penalty, but as liquidated damages. The Department may award the Contract to the next lowest responsive Bidder, re-advertise the Work, or take any other action decided by the Director.

104 SCOPE OF WORK

104.01 Intent of the Contract Documents. The intent of the Contract Documents is to provide for the construction and completion of the Work. Perform the Work according to the Contract Documents.

104.02 Revisions to the Contract Documents.

A. General. The Department reserves the right to revise the Contract Documents at any time. Such revisions do not invalidate the Contract or release the Surety, and the Contractor agrees to perform the Work as revised.

The provisions of this section are subject to the limitation of ORC 5525.14.

B. Differing Site Conditions. During the progress of the Work, if subsurface or latent physical conditions are encountered at the site differing materially from those indicated in the Contract Documents or if unknown physical conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the Work provided for in the Contract Documents, are encountered at the site, notify the Engineer as specified in 108.02.F of the specific differing conditions before they are disturbed or the affected Work is performed.

Upon notification, the Engineer will investigate the conditions and if it is determined that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any Work under the Contract, the Department will make an adjustment and modify the Contract as specified in 108.06 and 109.05. The Engineer will notify the Contractor of the determination whether or not an adjustment of the Contract is warranted.

C. Suspension of Work. If the performance of all or any portion of the Work is suspended or delayed by the Engineer in writing for an unreasonable period of time (not originally anticipated, customary, or inherent to the construction industry) and the Contractor believes that additional compensation or time is due as a result of such suspension or delay, notify the Engineer as specified in 108.02.

Upon receipt of notice, the Engineer will evaluate the Contractor's request. If the Engineer agrees that the cost or time required for the performance of the Work has increased as a result of such suspension and the suspension was caused by conditions beyond the control of and not the fault of the Contractor, its suppliers, or subcontractors at any approved tier, and not caused by weather, the Engineer will make an equitable adjustment (excluding profit) and modify the contract as specified in 108.06 and 109.05. The Engineer will notify the Contractor of its determination whether or not an adjustment to the Contract Documents is warranted. Failure of the Engineer to suspend or delay the Work in writing does not bar the Contractor from receiving a time extension or added compensation according to 108.06 or 109.05.

The Department will not make an adjustment under this subsection in the event that performance is suspended or delayed by any other cause, or for which an adjustment is provided or excluded under any other term or condition of this Contract.

D. Significant Changes in Character of the Work. The Engineer may increase or decrease quantities and alter the Work as necessary to complete the Project. The Engineer will make appropriate adjustments according to 108.06 and 109.05, if such alterations significantly change the character of the Work.

If the Contractor disagrees as to whether an alteration constitutes a significant change, use the notification procedures specified in 108.02.F.

The term "significant change" is defined as follows:

1. when the character of the Work as altered differs materially in kind or nature from that involved or included in the original proposed construction; or

2. when the product of the quantity in excess of the estimated quantity of a contract item and the unit price exceeds the limits set forth in Table 104.02-1.

TABLE 104.02-1

Contract Price	Contract Limits
Up to $500,000	$25,000
$500,001 to $2,000,000	5% of Total Contract Price
Over $2,000,000	$100,000

A quantity underrun is defined as follows:

a. the estimated quantity of a contract item exceeds four units (this minimum quantity does not apply to pavement markings measured in units of miles), and

b. the decrease in quantity of any unit price Contract Item exceeds 25 percent of the estimated quantity, and

c. the total of all such adjustments for all Contract Items is more than $400.

Then after the determination of final quantities according to 109.12.C, the Engineer will adjust the unit prices for the affected Contract item by multiplying the bid unit price by the factor obtained from Table 104.02-2.

TABLE 104.02-2

% Decrease	Factor	% Decrease	Factor
25	1.08	57	1.33
26 to 27	1.09	58	1.35
28 to 29	1.10	59	1.36
30 to 31	1.11	60	1.38
32 to 33	1.12	61	1.39
34 to 35	1.13	62	1.41
36	1.14	63	1.43
37 to 38	1.15	64	1.44
39	1.16	65	1.46
40 to 41	1.17	66	1.49
42	1.18	67	1.51
43	1.19	68	1.53
44 to 45	1.20	69	1.56
46	1.21	70	1.58
47	1.22	71	1.61
48	1.23	72	1.64
49	1.24	73	1.68
50	1.25	74	1.71
51	1.26	75	1.75
52	1.27	76	1.79
53	1.28	77	1.84
54	1.29	78	1.89
55	1.31	79	1.94
56	1.32	80 and over	2.00

When the increase in quantity or decrease in quantity of any unit price contract item does not exceed the limits set forth in Tables 104.02-1 and 104.02-2, the change is considered a minor change. The Department will pay for minor changes in the Work at the unit bid price.

E. Eliminated Items. The Department may partially or completely eliminate contract items.

The Department will only make an adjustment to compensate the Contractor for the reasonable cost incurred in preparation to perform significantly changed work as set forth in 104.02.D or work completely eliminated prior to the date of the Engineer's written order to significantly change or completely eliminate the Work. The adjustment will be determined according to 109.04 and 109.05. Such payment will not exceed the price of the Contract Item.

The Department will not seek a savings for maintaining traffic, mobilization, and construction layout stakes items for Eliminated Items of Work, unless there is a significant change.

F. Extra Work. Perform Extra Work as directed by the Engineer. The Department will pay for Extra Work as specified in 109.05. Time extensions, if warranted, will be determined according to 108.06.

G. Unilateral Authority to Pay. The Department has unilateral authority to pay the Contractor sums it determines to be due to the Contractor for work performed on the project. This unilateral authority to pay by the Department does not preclude or limit the rights of the Department and the Contractor to negotiate and agree to the amounts to be paid to the Contractor.

104.03 Rights in and Use of Materials Found on the Work. Upon obtaining the Engineer's approval, the Contractor may use material, such as stone, gravel, or sand, found in the plan excavation for another Contract Item. The Department will pay for both the excavation of the material under the corresponding Contract Item and for the placement of the excavated material under the Contract Item(s) for which the excavated material is used. Excavate or remove material only from within the grading limits, as indicated by the slope and grade lines.

Obtain written permission from the Engineer according to 107.11.A.

104.04 Cleaning Up. Maintain the Project in a presentable condition. Remove all rubbish, layout stakes, sediment control devices as directed by the Engineer, excess material, temporary structures, and equipment, including stream channels and banks within the Right-of-Way at drainage structures, and all borrow and waste areas, storage sites, temporary plant sites, haul roads, and other ground occupied by the Contractor in connection with the Work. Establish suitable vegetative cover in these areas by seeding and mulching according to Item 659, except for cultivated fields. Leave the Project site in an acceptable condition as determined by the Engineer. The cost of cleanup is incidental to all contract items. The Department may withhold 10 percent of the Bid amount for the mobilization contract item, if included, until performance under this section is complete. See 624.04.

105 CONTROL OF WORK

105.01 Authority of the Engineer. The Engineer will decide questions concerning all of the following:

A. The quality and acceptability of Materials furnished.

B. The quantity of Work performed.

C. The Contractor's rate of progress.

D. The interpretation of the Contract Documents.

E. Acceptable fulfillment of the Contract.

F. Contractor compensation.

The Engineer may suspend all or part of the Work when the Contractor fails to correct conditions that are unsafe for the workers or the general public, fails to comply with the Contract Documents, or fails to comply with the Engineer's orders. The Engineer may suspend the Work due to adverse weather conditions, conditions considered adverse to the prosecution of the Work, or other conditions or reasons in the public interest.

The Engineer's acceptance does not constitute a waiver of the Department's right to pursue any and all legal remedies for defective work or work performed by the Contractor in an un-workmanlike manner.

105.02 Plans and Working Drawings. The Plans show details of structures, the lines and grades, typical cross-sections of the Roadway, and the location and design of structures. Keep at least one set of Plans at the Project at all times.

Prepare working drawings when required by the Contract Documents and after verifying applicable field and plan elevations, dimensions, and geometries. Where Work consists of repairs, extension, or alteration of existing structures, take measurements of existing structures to accurately join old and new Work.

Unless otherwise indicated, the Department will review working drawing submittals to ensure conformance with the Contract and to provide the Contractor a written response to document the results of its review as follows:

A. "ACCEPTED." The Department accepts the submittal for construction, fabrication, or manufacture.

B. "ACCEPTED AS NOTED." The Department accepts the submittal for construction, fabrication, or manufacture, subject to the Contractor's compliance with all Department comments or corrections to the submittal. If also marked "RESUBMIT," the Department still accepts the submittal, but requires the Contractor to provide a corrected submittal to the Department.

C. "NOT ACCEPTED." The Department does not accept the submittal. The submittal does not conform to Contract requirements. Do not begin construction, fabrication, or manufacture of Work included in the submittal. Revise the submittal to comply with Department comments or corrections and Contract requirements and provide the revised submittal to the Department for another review.

"Accepted" and "Accepted as Noted" Working Drawings are Contract Documents as defined in 101.03. The Department's acceptance will not relieve the Contractor of responsibility to complete the Work according to the Contract nor relieve a signatory engineer's responsibility as defined by OAC 4733-23. Include the cost of furnishing Working Drawings in the cost of the Work they cover.

105.03 Conformity with Contract Documents. Perform all Work and furnish all Materials in reasonably close conformity with the lines, grades, cross-sections, dimensions, and material requirements as shown on the Plans and as specified.

If the DCA determines the Work is not in reasonably close conformity with the Contract Documents and determines the Contractor produced reasonably acceptable Work, the DCA may accept the Work based on engineering judgment. The DCA will document the basis of acceptance in a Change Order that provides for an appropriate adjustment to the Contract Price of the accepted Work or Materials. If the DCA determines the Work is not in reasonably close conformity with the Contract Documents and determines the Work is inferior or unsatisfactory, remove, replace, or otherwise correct the Work at no expense to the Department.

105.04 Coordination of the Contract Documents. The Contract Documents are those defined in 101.03. A requirement appearing in one of these documents is

as binding as though it occurs in all. The Engineer will resolve discrepancies using the following descending order of precedence:

A. Addenda.

B. Proposal and Special Provisions.

C. Plans.

D. Supplemental Specifications.

E. Standard Construction Drawings.

F. Standard Specifications.

Immediately notify the Engineer upon discovering any latent error or omission in the Contract Documents.

105.05 Cooperation by Contractor. The Department will supply the Contractor with two sets of the Contract Documents, except for the standard construction drawings, which will only be supplied if requested. The Department will provide only one copy of these Specifications.

Provide the constant attention necessary to progress the Work according to the Contract Documents. Cooperate with the Engineer, inspectors, and all other Contractors on or adjacent to the Project.

105.06 Superintendent. Provide a Superintendent for the Project that is available and responsive at all times and is responsible for all aspects of the Work, irrespective of the amount of subcontract Work. The Superintendent must be capable of reading and understanding the Contract Documents and experienced in the type of Work being performed. The Superintendent shall receive instructions from the Engineer or the Engineer's authorized representatives. The Superintendent shall promptly execute the Engineer's orders or directions and promptly supply the required materials, equipment, tools, labor, and incidentals.

105.07 Cooperation with Utilities. Unless otherwise provided for by the Contract Documents, the Department will direct the utility owners to relocate or adjust water lines, gas lines, wire lines, service connections, water and gas meter boxes, water and gas valve boxes, light standards, cableways, signals, and all other utility appurtenances within the limits of the proposed construction at no cost to the Contractor.

If the Contractor is directed by a utility company to perform any work not specifically contained in this note, the Department will not compensate the Contractor for this work unless the Department approves the request in writing before the work begins. If the work is not preapproved by the Department, the Contractor will be responsible for obtaining reimbursement for its work from the utility company which directed the Contractor to perform the work.

In the event that the Contractor requests that additional work, not specifically contained in this note, be performed by a utility company, the Contractor will be responsible for reimbursing the utility company for the additional work unless the Department has agreed in writing to pay for the additional work before the work begins.

The Contract Documents will indicate various utility items and indicate a time frame or date when the Department expects the owners to complete utility relocation or adjustment. Provide utility owners adjusting facilities during construction with adequate notification of the scheduled Work to prevent conflict with the Contractor's schedule of operations.

When bidding, consider all permanent and temporary utility appurtenances in present and relocated positions as shown in the Contract Documents.

According to ORC 153.64 and at least 2 Workdays prior to commencing construction operations in an area that may affect underground utilities shown on the Plans, notify the Engineer, the registered utility protection service, and the owners that are not members of the registered utility protection service.

The owner of the underground utility shall, within 48 hours, excluding Saturdays, Sundays, and legal holidays, after notice is received, start staking, marking, or otherwise designating the location, course, ±2 feet (±0.6 m), together with the approximate depth of the underground utilities in the construction area.

If the utility owners fail to relocate or adjust utilities as provided for in the Contract Documents and the Contractor sustains losses that could not have been avoided by the judicious handling of forces, equipment, and plant, or by reasonable revisions to the schedule of operations, then the Engineer will adjust the Contract according to 108.06 and 109.05.

105.08 Cooperation Between Contractors. At any time, the Department may contract for other work on or near the Project.

Separate Contractors working within the limits of the Project shall conduct their work without interfering with or hindering the progress or completion of Work being performed by other Contractors and shall cooperate with each other as directed by the Engineer.

105.09 Authority and Duties of the Inspector. Inspectors are authorized to inspect the Work and the preparation, fabrication, or manufacture of materials. Inspectors are not authorized to alter or waive requirements of the Contract Documents. Inspectors are authorized to notify the Contractor of Work that does not conform to the Contract; reject materials that do not conform to Specification requirements; and until the issue is decided by the Engineer, suspend portions of the Work if there is a question regarding the Contract Documents, use of unapproved material, or safety. Inspectors are not obligated or authorized to provide direction, superintendence, or guidance to the Contractor, its crew, its subcontractors, or suppliers to accomplish the Work.

Any action or inaction of the Inspector does not constitute a waiver of the Department's right to pursue any and all legal remedies for defective work or work performed by the Contractor in an un-workmanlike manner.

105.10 Inspection of Work. The Engineer may inspect materials and the Work. Provide the Engineer or the Engineer's representative access to the Work, information, and assistance necessary to conduct a complete inspection. Notify the Engineer at least 24 hours prior to all required inspections.

When directed by the Engineer, remove or uncover completed Work to allow inspection. After the Engineer's inspection, restore the Work according to the requirements of the Contract Documents. If the inspected Work conformed to the requirements of the Contract Documents, the Department will pay for uncovering or removing and restoring the Work as Extra Work according to 109.05. If the inspected Work did not conform to the Contract Documents, the Department will not pay for uncovering or removing and restoring the Work.

The Department shall have the discretion to dictate the level of inspection for any item of work. The Contractor bears sole responsibility for the quality of work and compliance with the contract regardless of the Department's level of inspection.

The Department's failure to identify defective Work or material shall not, in any way, prevent later rejection when defective Work or material is discovered, or obligate the Department to grant acceptance under 109.11 or 109.12.

Inspection of Work may include inspection by representatives of other government agencies or railroad corporations that pay a portion of the cost of the Work. This inspection will not make other government agencies or railroad corporations a party to the Contract and will not interfere with the rights of the Contractor or Department.

105.11 Removal of Defective and Unauthorized Work. Work that does not conform to the requirements of the Contract is defective.

Unless the Department formally accepts defective Work according to 105.03, immediately remove and replace defective Work.

Unauthorized Work is Work done contrary to the instructions of the Engineer, beyond the plan lines, or any extra work done without the Department's permission. The Department will not pay for unauthorized Work. The Engineer may order the Contractor to remove or replace unauthorized Work at no expense to the Department.

If the Contractor fails to comply with the Engineer's orders under the provisions of this subsection, the DCA may correct or remove and replace defective or unauthorized Work and deduct the costs from the Contract Price.

105.12 Load Restrictions. Comply with all legal load restrictions when hauling materials on public roads.

Operate equipment of a weight or so loaded as to not cause damage to structures, to the roadway, or to other types of construction. Comply with subsection 501.05.B.6 for allowed loads on bridges.

Do not use off road vehicles on bases or pavements unless permitted by the DCA in writing.

Do not haul on concrete pavement, base, or structures before the expiration of the curing period.

Do not exceed the legal load limits in this section unless permitted by the Director in writing.

105.13 Haul Roads. Prior to hauling equipment or materials, provide written notification to the Engineer of the specific roads or streets on the haul route. If the haul route includes roads and streets that are not under the jurisdiction and control of the State and the DCA determines that State controlled roads are not available or practical for a haul route, the Contractor may use local roads and streets that are not restricted by local authorities. If the DCA determines that state controlled roads are available and practical for a haul route, revise the proposed haul route provided in the original written notification and resubmit to the DCA.

If the Engineer determines that haul route roads were properly used during construction to haul equipment and materials and that the haul route roads were damaged, then the Engineer may order the Contractor to perform immediate and practical repairs to ensure reasonably normal traveling conditions. The Engineer will pay for repairs according to applicable provisions of 109.04 and 109.05.

The Contractor shall not file a claim for delays or other impacts to the Work caused by disputes with the local authorities regarding the use of local roads or streets as haul routes. The Contractor shall save the State harmless for any closures or hauling restrictions outside the Project limits beyond the control of the Department.

105.14 Maintenance During Construction. Maintain the Work during construction and until Final Inspector accepts the work under 109.12, except for portions of the Work accepted under 109.11. The Contractor is responsible for damage done by its equipment.

Maintain the previous courses or subgrade during all construction operations, when placing a course upon other courses of embankment, base, subgrade, concrete or asphalt pavement, or other similar items previously constructed. This maintenance includes, but is not limited to draining, re-compacting, re-grading, or if destroyed, the removal of Work previously accepted by the Department.

Maintain the Post Construction Storm Water Best Management Practice (BMP) features. Prevent sediment laden surface water from coming in contact with the BMP features during construction.

Maintain the Work during construction and before acceptance of the Work under 109.12, except for portions of the Work accepted under 109.11. The Department will not provide additional compensation for maintenance work.

105.15 Failure to Maintain Roadway or Structure. If the Contractor, at any time, fails to comply with the provisions of 105.14, the Engineer will immediately notify the Contractor of such noncompliance. If the Contractor fails to remedy unsatisfactory maintenance within 24 hours after receipt of such notice, the Engineer may immediately proceed to maintain the Project, and deduct the entire cost of this maintenance from monies due or to become due the Contractor on the Contract.

105.16 Borrow and Waste Areas. Prior to beginning borrow or wasting operations, obtain the Engineer's written approval of a detailed operation plan that addresses the following concerns:

A. Control of drainage water.

B. Cleanup, shaping, and restoration of disturbed areas.

C. Disposal of regulated materials.

D. Avoidance of regulated areas.

E. Excavation and filling of waste and borrow areas.

F. Saving of topsoil.

G. Temporary Sediment and Erosion Control BMPs required for compliance under the Clean Water Act, Ohio Water Pollution Control Act, (OWPCA) (ORC Chapter 6111) and the NPDES permit.

Perform all engineering necessary to ensure long term stability of all side slopes and foundations of all borrow and waste areas. Furnish a certification by a Registered Engineer attesting to the stability of all borrow and waste areas. All damage resulting from the instability of borrow and waste areas, the removal of borrow materials, the placement of waste materials, or the hauling of material to and from these areas is the sole responsibility of the Contractor. Repairs to approved haul roads will be made in accordance with 105.13.

Perform all engineering, including any field investigation, necessary to ensure long term stability of all side slopes and foundations of all borrow and waste areas.

Ensure that all side slopes of all waste areas do not reduce horizontal sight distance as defined by the current version of the Department's *Location and Design Manual*.

Have the proposed borrow and waste areas reviewed by an environmental consultant that is pre-qualified by the Department for ecological work. Have the environmental consultant certify that the proposed borrow and waste operations will not impact the "Waters of the United States" or an isolated wetland. If consultant certification is not provided, obtain the 404/401 permits necessary to perform the operations as proposed. Have the environmental consultant certify that the work conforms to the requirements of the permit(s). Provide all documentation submitted to obtain the appropriate permit(s) and a copy of the permit(s) to the Department's Office of Environmental Services.

If burning is permitted under the OAC-3745-19 and ORC 1503.18, submit a copy of the Ohio EPA permit and the Ohio DNR permit to the Engineer and copies of all information used to obtain the permit.

Prior to the disposal of waste materials, submit to the Department an executed copy of the Contract or permission statement from the property owner. The Contract or permission statement must indicate that the waste materials are not the property of the Department. Further, it must expressly state that the Department is not a party to the Contract or permission statement and that the Contractor and property owner will hold the Department harmless from claims that may arise from their contract or permission statement.

Restoration of all borrow or waste areas includes cleanup, shaping, replacement of topsoil, and establishment of vegetative cover by seeding and mulching according to 104.04 and Item 659. Ensure the restored area is well drained unless approval is

given by the Engineer to convert a pit area into a pond or lake, in which case confine restoration measures to the disturbed areas above the anticipated normal water level.

For waste sites shown on the plan, the plan will indicate if the clearances have or have not been obtained for the project right-of-way locations. No extension of time or additional compensation will be paid for any delays due to not having the written permit(s) to waste in a floodplain.

The allowed use of Project Right-of-Way and other Department property for borrow and waste is detailed in 104.03 and 107.11.

Borrow and Waste Area shall adhere to 107.10.

The cost of work described herein is incidental to the Contract, unless included under another item of work.

105.17 Construction and Demolition Debris. OAC-3745-37, OAC-3745-400, and ORC Chapter 3714 regulates the use and disposal of construction and demolition debris. Notify the local Board of Health or the local Ohio EPA office 7 days before placing Clean Hard Fill off the Right-of-Way. Submit copies of this notification to the Engineer.

Legally dispose of debris containing wood, road metal, or plaster at a licensed construction and demolition debris site.

Under the regulations cited above the disposal of brush, trees, stumps, tree trimmings, branches, weeds, leaves, grass, shrubbery, yard trimmings, crop residue, and other plant matter is restricted. If allowed by the Contract Documents, the Contractor may waste brush, trees, stumps, tree trimming, branches, weeds, leaves, grass, shrubbery, yard trimmings, crop residue, and other plant matter within the Right-of-Way. Otherwise, submit a plan and any required permits to legally dispose of these materials off the Right-of-Way to the Engineer. Provide all documents submitted to obtain this permit to the Engineer.

If the Project contains garbage or solid and hazardous waste, the Contract Documents will detail the removal of these items.

When wasting PCC, mix the PCC with at least 30 percent natural soil to construct an inner core in the waste area. Cover this inner core with 3 feet (1.0 m) of natural soil on the top and 8 feet (2.4 m) on the side slopes. Place and compact the material according to 203.06.D to prevent future settlement and sliding.

Clean Hard Fill consisting of reinforced or non-reinforced concrete, asphalt concrete, brick, block, tile or stone that is free of all steel as per 703.16 shall be managed in one or more of the following ways:

A. Recycled into a usable construction material.

B. Disposed in licensed construction and demolition debris facility.

C. Used in legitimate fill operations on the site of generation according to 105.16.

D. Used in legitimate fill operations on a site other than the site of generation to bring a site up to grade.

A Beneficial Reuse Certification form needs to be properly executed by the Recipient prior to any material leaving the project.

105.18 Acceptance. The Department will accept Work according to 109.12 or completed sections of the Project according to 109.11.

105.19 Value Engineering Change Proposals. The Department will partner with the Contractor by considering a Contractor's submission of a Value Engineering Change Proposal (VECP) which may reduce the overall construction cost on projects not containing Design Build provisions. Savings in construction costs will be shared equally between the Contractor and the Department. The Department will partner with the Contractor by considering a VECP for time savings on projects not containing time-based award provisions. The economic value of the savings in time will be shared equally between the Contractor and Department, however the impacted completion date shall be adjusted the full amount. Time savings VECPs may increase contract value if accepted by the Department. Time savings VECPs shall not consist of only acceleration and shall contain a substantial amount of material savings as determined by the Department.

The Contractor's costs for development, design and implementation of the VECP are not eligible for reimbursement. The VECP must not impair any of the essential functions and characteristics of the project such as service life, reliability, economy of operation, ease of maintenance, safety and necessary standardized features. The VECP designer may not be the ODOT designer of record. The submission of the VECP shall conform to Supplement 1113.

The Department will not approve VECPs with any of the following characteristics:

A. Consist only of non-performing items of work contained in the plans.

B. Include identified plan errors as part of the cost reduction, at the discretion of the Department.

C. Changes to any special architectural or aesthetic treatments or requires changes to NEPA commitments.

D. Requires concrete beams to be installed with less than 17' vertical clearance over a state highway.

E. Changes the type or buildup of permanent pavement.

F. Compromises controlling design criteria or would require a design exception as discussed in Volume I, Section 100, of the Location and Design Manual.

G. Proposes a time savings to any portion of work on a project which has an Incentive / Disincentive clause associated with Project award.

VECP engineering, design development and implementation costs are not recoverable. Contractor costs or delays due to the Department's review or rejection of the VECP are not recoverable.

The Department may reject the Contractor's initial VECP or portions thereof and may proceed with such revisions without any obligations to the Contractor if the

Department already is considering revisions to the contract which are subsequently proposed as a VECP.

Acceptance of a VECP is at the sole discretion of the Director and may be rejected for any reason.

106 CONTROL OF MATERIAL

106.01 Source of Supply and Quality Requirements. Notify the Engineer of the proposed sources of supply before the delivery of materials. The Engineer may approve materials at the source of supply before delivery. If the proposed sources of supply cannot produce the specified material, then furnish materials from alternate sources without adjustment to the Contract Price or Completion Date.

106.02 Samples, Tests, and Cited Specifications. The Engineer will inspect and determine whether the materials comply with the specified requirements before they are incorporated into the Work. The Department may sample and test materials or require certifications. Unless specified, the Department will pay for and test materials according to AASHTO, ASTM, or the methods on file in the office of the Engineer. A qualified representative of the Department will take test samples according to Departmental procedures. Read any reference to other specifications or testing methods to mean the version in effect at the pertinent Project Advertisement date. All materials being used are subject to inspection, test, or rejection at any time before their incorporation into the Work. The Department will furnish copies of the tests to the Contractor's representative upon request. Furnish the required samples and specified material certifications at no expense to the Department other than provided in 109.03.

Equip all transports and distributors hauling asphalt material with an approved submerged asphalt material sampling device.

106.03 Small Quantities and Materials for Temporary Application. The Engineer may accept small quantities and materials for temporary application that are not intended for permanent incorporation in the Work. The Engineer may accept these small quantities and materials for temporary application in either of the following cases:

A. Where similar materials from the same source have recently been approved.

B. Where the materials, in the judgment of the Engineer, will serve the intended purpose.

106.04 Plant Sampling and Testing Plan. The Engineer may undertake the inspection of materials at the source.

In the event plant sampling and testing is undertaken, the Contractor and its material provider shall meet the following conditions:

A. Cooperate and assist the Engineer with the inspection of materials. Provide full entry to the Engineer at all times to such parts of the plant as may concern the manufacture or production of the materials being furnished. Agree to all

documentation and inspection requirements of the TE-24 plant sampling and testing plan.

B. If required by the Engineer, arrange for the inspector to use an approved building on site. The building should be located near the plant and independent of any building used by the material producer.

C. Maintain and provide adequate safety measures at the plant at all times.

The Department reserves the right to retest all materials that have been tested and accepted at the source of supply before their incorporation into the Work. After the approved materials have been delivered to the site, the Department may reject all materials that when retested do not meet the requirements of the Contract Documents.

106.05 Storage of Materials. Properly store all materials to ensure the preservation of their quality and fitness for the Work. The Engineer may re-inspect stored materials before their incorporation into the Work, even though they were approved before storage. Locate stored materials to facilitate their prompt inspection. The Contractor may use approved portions of the Project Right-of-Way for storage; however, if any additional space is required, the Contractor must provide it at the Contractor's expense. Do not use private property for storage purposes without written permission from the owner or lessee. If requested by the Engineer, furnish copies of the written permission. Restore all storage sites to their original condition at no expense to the Department. The Contractor and property owner will hold the Department harmless from claims that may arise from their contract or permission statement. This subsection does not apply to the stripping and storing of topsoil, or to other materials salvaged from the Work.

Areas used to Store Materials shall conform to 107.10.

106.06 Handling Materials. Handle all materials in such manner as to preserve their quality and fitness for the Work. Transport aggregates from the storage site to the project site in vehicles constructed to prevent loss or segregation of materials after loading and measuring. Ensure that there are no inconsistencies in the quantities of materials loaded for delivery and the quantities actually received at the place of operations.

106.07 Unacceptable Materials. Unacceptable materials are all materials not conforming to the requirements of these Specifications at the time they are used. Immediately remove all unacceptable materials from the project site unless otherwise instructed by the DCA. The DCA will determine if unacceptance materials may remain conforming to Supplement 1102. The DCA must approve the use of previously identified unacceptable materials that have been corrected or repaired. If the Contractor fails to comply immediately with any order of the DCA made under the provisions of this subsection, the DCA will have authority to remove and replace defective materials and to deduct the cost of removal and replacement from any monies due or to become due to the Contractor.

106.08 Department-Furnished Material. Furnish all materials required to complete the Work, except when otherwise provided in the Proposal.

The Department will deliver the Department-furnished materials to the Contractor at the points specified in the Contract Documents.

Include the cost of handling and placing of all Department-furnished materials in the contract price for the contract item for which they are used.

The Department will hold the Contractor responsible for all material upon delivery of the materials to the Project site. The Department will make deductions from any monies due the Contractor to make good any shortages and deficiencies, for any cause whatsoever, and for any damage that may occur after such delivery, and for any demurrage charges.

106.09 Steel and Iron Products Made in the United States. Furnish steel products that are made in the United States according to the applicable provisions of State of Ohio laws, ORC 153.011 and 5525.21. "United States" means the United States of America and includes all territory, continental or insular, subject to the jurisdiction of the United States.

A. State Requirements. All steel products used in the Work for load-bearing structural purposes must be made from steel produced in the United States. State requirements do not apply to iron.

B. Exceptions. The Director may grant specific written permission to use foreign steel products in bridge construction. The Director may grant such exceptions under either of the following conditions:

1. The cost for each contract item used does not exceed 0.1 percent of the total contract cost, or $2,500, whichever is greater. For the purposes of this section, the cost is the value of the steel product as delivered to the project..

2. The director determines that specified steel materials are not produced in the United States in sufficient quantity or otherwise are not reasonably available to meet contract requirements.

C. Proof of Domestic Origin. Furnish documentation to the Engineer showing the domestic origin of all steel products covered by this section, before they are incorporated into the Work. Products without a traceable domestic origin will be treated as a non-domestic product.

106.10 Qualified Products List. The Department may use Qualified Product Lists (QPL) for approval of manufactured materials. The Office of Materials Management (OMM) will maintain the QPL and the standard procedure for the QPL process. Inclusion of a material onto the QPL will be determined by OMM with support from other Department offices. To be kept on the QPL, manufacturers must recertify their material according to the Department's standard procedure by January 1 of each year. When a material requires QPL acceptance, only provide materials listed on the QPL at the time of delivery of the material to the project. Provide the Engineer documentation according to the Department's standard procedure that, at the time of delivery, the material provided is on the QPL.

106.11 Maritime Transportation. On federal-aid projects, ensure that project-specific materials or equipment transported by ocean vessel are in compliance with 46 CFR 381 and the Cargo Preference Act. Transport at least 50% of any equipment or materials on privately owned United States-flag commercial vessels, if available.

106.12 Traffic Authorized Product. The Department may use Traffic Authorized Product (TAP) List for approval of products used in Intelligent Transportation Systems (ITS) or Traffic Signal Systems. The Office of Traffic Operations will maintain the TAP and the standard procedure for the TAP process. Inclusion of a product onto the TAP will be determined by Office of Traffic Operations with support from other Department offices. To be kept on the TAP, manufacturers must recertify their product according to the Department's standard procedure by February 28 of each year. When a product requires TAP acceptance, only provide products listed on the TAP at the time of delivery of the product to the project. Provide the Engineer documentation according to the Department's standard procedure that, at the time of delivery, the material provided is on the TAP.

106.13 Certified Supplier. The Department may use Certified Suppliers for approval of manufactured materials. The Office of Materials Management (OMM) will maintain the Certified Supplier list and the procedure for the Certified Supplier process. Inclusion of a material onto the Certified Supplier list will be determined by OMM with support from other Department offices. Administration of the Certified Supplier Program will be in accordance with Supplement 1139.

107 LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC

107.01 Laws to be Observed. Stay fully informed of all Federal and State laws, all local laws, ordinances, and regulations, and all orders and decrees of authorities having any jurisdiction or authority that affect those engaged or employed on the Work, or that affect the conduct of the Work. Observe and comply with all such laws, ordinances, regulations, orders, and decrees. The Contractor shall protect and indemnify the State and its representatives against any claim or liability arising from or based on the violation of any such law, ordinance, regulation, order, or decree, whether by the Contractor or the Contractor's employees, subcontractors, or agents.

The Contractor, under Title VI of the Civil Rights Act and related statutes, agrees that in the hiring of employees for the performance of Work under this Contract or any subcontract hereunder, neither the Contractor, the subcontractor, nor any person acting on behalf of such Contractor or subcontractor shall, by reasons of race, religion, color, sex, national origin, disability or age, discriminate against any citizen of the United States in the employment of labor or workers, who is qualified and available to perform the Work to which the employment relates.

Neither the Contractor, the subcontractor, nor any person on their behalf shall, in any manner, discriminate against or intimidate any employee hired for the performance of Work under this Contract on account of race, religion, color, sex, national origin, disability or age.

Comply with OAC-4123:1-3, entitled "Specific Safety Requirements of the Industrial Commission of Ohio Relating to Construction," as amended, and with the Federal Occupational Safety and Health Act of 1970 and Code of Federal Regulations, Title 29, Chapter XVII, Part 1926 and as amended.

107.02 Permits, Licenses, and Taxes. Procure all permits and licenses; pay all charges, fees, and taxes; and provide all notices necessary and incidental to the due and lawful prosecution of the Work.

107.03 Patented Devices, Materials, and Processes. Before employing any design, device, material, or process covered by letters of patent or copyright, provide for its use by suitable legal agreement with the patentee or owner. The Contractor and the Surety shall indemnify and save harmless the State, any affected third party, or political subdivision from any and all claims for infringement of patented design, device, material, process, or any trademark or copyright, and shall indemnify the State for any costs, expenses, and damages that it may be obliged to pay by reason of any infringement, at any time during the prosecution or after the completion of the Work.

107.04 Restoration of Surfaces Opened by Permit. The Director may grant to the municipality in which the Work is performed a reservation of rights to construct or reconstruct any utility service in the highway or street or to grant permits for same, at any time.

Any individual, firm, or corporation wishing to make an opening in the highway must secure a permit. Allow parties bearing such permits, and only those parties, to make openings in the highway. When ordered by the Engineer, make in an acceptable manner all necessary repairs due to such openings. The necessary repairs will be paid for as Extra Work, or as provided in the Contract Documents, and will be subject to the same conditions as the original Work performed.

107.05 Federal-Aid Provisions. When the United States Government pays for all or any portion of the Project's cost, the Work is subject to the inspection of the appropriate Federal agency.

Such inspections will not make the Federal Government a party to this Contract. The inspections will in no way interfere with the rights of either party to the Contract.

107.06 Sanitary Provisions. Provide and maintain sanitary accommodations in a neat condition for the use of employees and Department representatives that comply with the requirements of the State and local Boards of Health, or of other authorities having jurisdiction over the Project.

107.07 Public Convenience and Safety. At all times, ensure that the Work interferes as little as possible with the traffic. Provide for the safety and convenience of the general public and the residents along the highway and the protection of persons and property. Do not close any highways or streets unless specifically allowed by the Contract.

Any illegal drugs, drug paraphernalia, mobile drug labs or dumps, weapons or firearms found on the Project Right of Way shall be considered a potential crime scene and shall not be handled or moved. Immediately notify law enforcement and the Project Engineer.

107.08 Bridges Over Navigable Waters. Conduct all Work on navigable waters so that it does not interfere with free navigation of the waterways and that it does not alter the existing navigable depths, except as allowed by permit issued by the U.S. Coast Guard. Work within the flood plain of a navigable stream may require a permit from the U.S. Army Corps of Engineers. If an U.S. Army Corps of

Engineers permit is required, provide all documentation submitted to obtain the permit(s) and a copy of the permit(s) to the Department.

107.09 Use of Explosives. When the use of explosives is necessary for the prosecution of the Work, exercise the utmost care not to endanger life or property, including new Work. The Contractor is responsible for all damage resulting from the use of explosives.

Obtain written permission to perform in-stream blasting from the Chief of the Division of Wildlife, Ohio DNR according to ORC 1533.58. Provide the Engineer with all documentation submitted to obtain this permit and with a copy of the permit.

The Contractor agrees, warrants, and certifies that it will observe State laws and local ordinances and regulations relative to the use and storing of explosives kept on the Project site.

Perform all blasting operations according to Item 208.

107.10 Protection and Restoration of Property. The Contractor is responsible for the preservation of all public and private property impacted by the Contractor's operations.

The Contractor is responsible for all damage or injury to property, during the prosecution of the Work, resulting from any act, omission, neglect, defective work or materials, or misconduct in the manner or method of executing the Work. The Contractor will remain responsible for all damage and injury to property until the Project is accepted under 109.12, except for portions of the Work accepted under 109.11.

If the Contractor causes any direct or indirect damage or injury to public or private property by any act, omission, neglect, or misconduct in the execution or the non-execution of the Work, then it must restore, at its own expense, the property to a condition similar or equal to that existing before the damage or injury.

If mail boxes, road, or street name signs and supports interfere with the Work, then remove and erect them in a temporary location during construction in a manner satisfactory to and as directed by the Engineer. After completion of the Work and before final acceptance of the Project, erect the mailboxes, road, or street name signs and supports in their permanent locations according to the plans unless otherwise directed by the Engineer. Consider the cost of this Work as incidental to the affected items.

Cooperate with the Engineer in protecting and preserving survey monuments that are affected by the Work as required by ORC 5519.05. At the beginning of the Work, verify the position of all survey monuments in the area to be improved, according to 623. If survey monuments not shown in the Contract Documents are unexpectedly encountered, then protect, reference, and preserve them in the same manner as survey monuments that are shown in the Contract Documents.

Do not create staging areas, store materials and equipment, or borrow or waste materials in areas labeled as an environmental resources areas in the Contract Documents. All properties to be utilized by the Contractor outside the project Work Limits must be cleared for all environmental resource impacts prior to the beginning of work. Environmental resources include but may not be limited to:

1. Cultural Resources

a. Buildings, structures, objects, and sites eligible for or listed on the National Register of Historic Places

b. Historic or prehistoric human remains, cemeteries, and/or burial sites (pursuant with ORC 2909.05 and 2927.11

2. Ecological Resources

a. Wetlands

b. Streams

c. Wooded areas with trees to be removed in excess of 8 inches diameter at breast height

3. Public Lands

a. Lands meeting the criteria of 49 U.S.C. 303, 23 CFR 771.I35: 4(f).

b. Lands meeting the criteria of 16 U.S.C. 4601-4, 36 CFR59.1: 6(f).

4. FEMA Mapped 100 year Floodplains

5. Hazardous Waste Areas

Except for locations utilized specifically for:

1. Parking of equipment between workdays for maintenance type projects:

2. Reuse of Clean Hard Fill as described in CA-EW-20 (ODOT Beneficial Reuse Form). Prior to transferring Clean Hard Fill from the project, fully execute form CA-EW-20 and provide appropriate documentation to the Engineer as described for each reuse option.

All areas proposed to be utilized by the Contractor outside the project construction limits and not described above shall be reviewed by environmental Contractor(s) that are prequalified by the Department for each environmental resource. Exception (1.) noted above only applies to projects with “maintenance” in the project description. Have the consultant(s) certify that the proposed site to be utilized for the Contractor will not impact:

1. Cultural Resources
2. Ecological Resources
3. Public Lands
4. FEMA Mapped 100 year Floodplains
5. Hazardous Waste Areas

Provide all documentation and the consultant certification to the Office of Environmental Services with a copy to the Engineer.

Should the areas proposed for use by the Contractor outside the project right of way limits contain environmental resources the Contractor is responsible to the

Department for all environmental clearances and permits prior to the beginning of work.

107.11 Contractor's Use of the Project Right-of-Way or Other Department-Owned Property.

A. Disposal of Waste Material and Construction Debris and Excavation of Borrow on the Project Right-of-Way or on Other Department-Owned Property. Dispose of waste material according to 105.16 and dispose of construction debris according to 105.17. In addition to the rights granted in 104.03, the Contractor's use of the Project Right-of-Way or other Department-owned property for the disposal of waste material and construction debris and excavation of borrow material is restricted as follows:

1. If the Contract Documents identify locations for the disposal of waste material and construction debris or excavation of borrow material within the Project Right-of-Way or on other Department-owned property, then only perform these operations in these designated locations.

2. If the Contract Documents do not identify locations for the disposal of waste material and construction debris or excavation of borrow material within the Project Right-of-Way or on other Department-owned property, then do not Bid assuming that the Department will make such locations available.

If the Contractor's request to use locations within the Project Right-of-Way or on other Department-owned property is approved by the Engineer, then the Department may allow the Contractor to dispose of waste material and construction debris or excavate borrow material for a fee of $0.50 per cubic yard.

B. Contractor's Use of Portable Plants Within the Project Right-of-Way or on Other Department-Owned Property. The Contractor's use of portable plants within the Project Right-of-Way or on other Department-owned property is limited as follows:

1. If the Contract Documents identify locations within the Project Right-of-Way or on other Department-owned property to place a portable plant, then only place a portable plant in these designated locations subject to the requirements of 107.11.C.

2. If the Contract Documents do not identify locations within the Project Right-of-Way or on other Department-owned property to place a portable plant, then do not bid assuming that the Department will make such locations available.

However, the Department will consider a Value Engineering Change Proposal (VECP) for the placement of a portable plant within the Project Right-of-Way or on other Department-owned property and, if accepted, may allow the use of a particular site on its property subject to the requirements of 107.11.C.

C. Placement of a Portable Plant within the Project Right-of-Way or on Other Department-Owned Property. To place a portable plant within the Project Right-of-Way or on other Department-owned property, comply with the following requirements:

1. Local noise ordinances.

2. Obtain any necessary EPA permits for the operation of the plant. Provide the Department with a copy of the information submitted to obtain the permit and a copy of the permit.

3. Provide the Engineer written certification that the plant will supply material only for the Project for which it was approved. Do not use the plant to supply any other project or to sell materials commercially.

4. Submit a traffic control plan to the Engineer for approval that details the anticipated truck movements and provides acceptable protection, warning, and guidance to motorists, pedestrians, and the workers.

D. Equipment Storage and Staging. The Contractor may use, fee-free, any portion of the Project within the Project Right-of-Way for staging, equipment storage, or an office site with the approval of the Engineer, provided such usages do not interfere with the Work and are not prohibited by the Contract Documents. Do not bid in anticipation of using any properties within the Project Right-of-Way or Department-owned property outside the Project Right-of-Way for equipment storage or staging.

E. Equipment Removal and Site Restoration. Remove all Contractor equipment and completely restore all utilized sites used as required by 104.04 before Final Acceptance as provided in 109.12.

107.12 Responsibility for Damage Claims and Liability Insurance. The Contractor shall indemnify and save harmless the State and all of its representatives, municipalities, counties, public utilities, any affected railroad or railway company, and any fee owner from whom a temporary Right-of-Way was acquired for the Project from all suits, actions, claims, damages, or costs of any character brought on account of any injuries or damages sustained by any person or property on account of any negligent act or omission by the Contractor or its subcontractors or agents in the prosecution or safeguarding of the Work.

The Contractor shall procure and maintain insurance for liability for damages imposed by law and assumed under this Contract, of the kinds and in the amounts hereinafter provided from insurance companies authorized to do business in the State by the Ohio Department of Insurance. The cost of insurance is incidental to all contract items. Before the execution of the Contract by the Director, furnish to the Department a certificate or certificates of insurance in the form satisfactory to the Department demonstrating compliance with this subsection. Provide an insurance certificate or certificates that show that the Contractor's liability and auto policies coverage are not reduced, restricted, or canceled until 30 days written notice has been given to the Department by the insurer. Mail all certificates and notices to: Administrator, Office of Contracts, Ohio Department of Transportation, 1980 West Broad Street, Columbus, Ohio 43223. Upon request, the Contractor shall furnish the Department with a certified copy of each policy, including the provisions establishing premiums.

The types and minimum limits of insurance are as follows:

A. Workers' Compensation Insurance. Comply with all provisions of the laws and rules of the Ohio Bureau of Workers' Compensation covering all operations

under Contract with the Department whether performed by it or its subcontractors. In addition, if a portion of the Work is performed from a barge or ship or requires unloading material from a barge or ship on a navigable waterway of the United States, it is the responsibility of the Contractor to arrange coverage for that portion of the Work under the Longshore and Harborworkers' Compensation Act [33 USC Section 901 *et seq.*] and the Jones Act [5 USC Section 751 *et seq.*] and provide proof of coverage to the Department.

B. Commercial General Liability Insurance. The minimum limits for liability insurance are as follows:

General Aggregate Limit	$2,000,000
Products - Completed Operations Aggregate Limit	$2,000,000
Personal and Advertising Injury Limit	$1,000,000
Each Occurrence Limit	$1,000,000

Obtain the above minimum coverages through primary insurance or any combination of primary and umbrella insurance. In addition, the Department will require the General Aggregate Limit on a per project basis.

Ensure that the Commercial General Liability Insurance policy names the State of Ohio, Department of Transportation, its officers, agents, and employees as additional insureds with all rights to due notices in the manner set out above. Obtain Explosion, Collapse, and Underground (XCU) coverage at the same limits as the commercial general liability insurance policy. In addition, if blasting is to be performed, obtain XCU coverage providing a minimum Aggregate Limit of $5,000,000 and Each Occurrence Limit of $1,000,000. Submit proof of insurance, endorsements, and attachments to the Engineer prior to starting the Work.

C. Comprehensive Automobile Liability Insurance. The Comprehensive Automobile Liability policy shall cover owned, non-owned, and hired vehicles with minimum limits as follows:

Bodily Injury and Property Damage Liability Limit	
Each Occurrence	$1,000,000

Insurance coverage in the minimum amounts set forth neither relieves the Contractor from liability in excess of such coverage, nor precludes the Department from taking such other actions as are available to it under any other provisions of this Contract or otherwise in law.

Clearly set forth all exclusions and deductible clauses in all proof of insurance submitted to the Department. The Contractor is responsible for the deductible limit of the policy and all exclusions consistent with the risks it assumes under this Contract and as imposed by law.

If the Contractor provides evidence of insurance in the form of certificates of insurance, valid for a period of time less than the period during which the Contractor is required by terms of this Contract, then the Department will accept the certificates, but the Contractor is obligated to renew its insurance policies as necessary. Provide new certificates of insurance from time to time, so that the Department is

continuously in possession of evidence that the Contractor's insurance is according to the foregoing provisions.

If the Contractor fails or refuses to renew its insurance policies or the policies are canceled or terminated, or if aggregate limits have been impaired by claims so that the amount available is under the minimum aggregate required, or modified so that the insurance does not meet the requirements of 107.12.C, the Department may refuse to make payment of any further monies due under this Contract or refuse to make payment of monies due or coming due under other contracts between the Contractor and the Department. The Department in its sole discretion may use monies retained pursuant to this subsection to renew or increase the Contractor's insurance as necessary for the periods and amounts referred to above. Alternatively, should the Contractor fail to comply with these requirements, the Department may default the Contractor and call upon the Contractor's Surety to remedy any deficiencies. During any period when the required insurance is not in effect, the Engineer may suspend performance of the Contract. If the Contract is so suspended, the Contractor is not entitled to additional compensation or an extension of time on account thereof.

Nothing in the Contract Documents and insurance requirements is intended to create in the public or any member thereof a third party beneficiary hereunder, nor is any term and condition or other provision of the Contract intended to establish a standard of care owed to the public or any member thereof.

107.13 Reporting, Investigating, and Resolving Motorist Damage Claims. The Contractor and the Department are required to report, investigate, and resolve motorist damage claims according to 107.10 and 107.12 and as follows.

When a motorist reports damage to its vehicle either verbally or in writing to the Contractor, the Contractor shall within 3 days make and file a written report to the District's construction office In the event that the Department directly receives the motorist's claim, the Department shall within 3 days send the claim report to the Contractor. In the event the Contractor has not agreed to resolve the motorist claim, the District's construction office shall forward the report to the Department's Court of Claims Coordinator who, as a co-insured party, may then contact the Contractor's insurance company and request that the insurance company investigate and resolve the claim. If the Contractor or their insurance company does not resolve the claim in a timely manner, the Department may advise the motorist of the option of pursuing the claim in the Ohio Court of Claims.

In the event of a lawsuit filed against the Department in the Ohio Court of Claims by the motorist, the Department, as co-insured party, may request the Contractor's insurance company to defend this lawsuit and hold the Department harmless according to 107.12.

If the lawsuit claim amount is $2,500 or less and the Court of Claims Coordinator determines that the Contractor is responsible for the claimed damages then the Department's Court of Claims Coordinator may, after notifying the Contractor, determine that it would be in the best interest of the Department to settle the claim. Any settlement amount including court costs may be assessed to the Contractor and deducted from the project. The Engineer will notify the Contractor prior to executing

the deduction. The Contractor or the Contractor's insurance company may within 14 days appeal the assessment decision of the Court of Claims Coordinator to the District Construction Engineer. The decision of the DCE will be made within 14 days and will be administratively final.

107.14 Opening Sections of Project to Traffic. The Engineer may order the Contractor to open a section of the Work to the safe use of traffic at any time. The Department will make an adjustment according 108.06 and 109.05 to compensate the Contractor for the added costs and delay, if any, resulting from such an opening.

107.15 Contractor's Responsibility for Work. Until the Final Inspector accepts the Work during the Final Inspection according to 109.12.A, the Contractor is responsible for the Project and will take every precaution against injury or damage to any part thereof by the action of the elements or from any other cause, whether arising from the execution or from the non-execution of the Work. Rebuild, repair, restore, and make good all injuries or damages to any portion of the Work occasioned by any of the above causes before final acceptance. Bear the expense of the repairs except when damage to the Work was due to unforeseeable causes beyond the control of and without the fault or negligence of the Contractor. Unforeseeable causes include but are not restricted to; (a) earthquake, floods, tornados, high winds, lightning or other catastrophes proclaimed a disaster or emergency, (b) slides, (c) civil disturbances, or (d) governmental acts.

In the event that the Engineer determines that damage to completed permanent items of Work results from traffic using a substantially completed section of Roadway, the Department may compensate the Contractor for repair of the damage as authorized by Change Order. Additionally, if traffic permanently damages beyond use and of the following temporary maintenance of traffic items, the Department may compensate the Contractor for replacement of the item as authorized by Change Order:

Arrow board,

Work zone signal, pole, or controller,

Lighting unit or pole,

Changeable message sign,

Work Zone Impact Attenuator,

Truck Mounted Impact Attenuator,

Digital Speed Limit Sign Assembly.

To receive compensation for the damage to permanent items of Work or temporary maintenance of traffic items named above, the Contractor must first meet the following requirements.

A. Notify the Engineer of each occurrence of damage in writing within 10 Calendar Days.

B. Contact the local law enforcement agency to determine if the accident was investigated and a report filed. If an accident report was filed, obtain the report and notify the motorist, and copy their insurance company, via certified mail informing

both that the motorist is responsible for the cost of damage repairs. If the motorist does not respond within 30 days, make a second attempt to contact the motorist and copy the insurance company via certified mail.

C. If no response is received from the motorist or insurance company within 30 days of the motorist receipt of the second notice, send a letter to the Engineer within eighteen months of the event and include documentation of good faith effort to seek recovery from responsible parties.

D. The Department will make an adjustment according to 108.06 and 109.05 to compensate the Contractor for the added costs and delays, if any, resulting from the repair or replacement of damaged Work.

If there is no accident report on file and no means of identifying the responsible motorist, the Contractor may likewise be compensated to repair the damaged Work.

In case of suspension of Work by the Contractor or under the provisions of 105.01, the Contractor is responsible for the Project and shall take necessary precautions to prevent damage to the Project; provide for normal drainage; and erect any necessary temporary structures, signs, or other facilities at its expense. During such period of suspension of Work, properly and continuously maintain in an acceptable growing condition all living material in newly established plantings, seedings, and soddings furnished under the Contract, and take adequate precautions to protect new tree growth and other important vegetative growth against injury.

The Engineer may direct the Contractor to remove graffiti any time during the Work. The Department will make an adjustment according to 108.06 and 109.05 to compensate the Contractor for the added costs and delays, if any, resulting from all ordered graffiti removal.

107.16 Contractor's Responsibility for Utility Property and Services. At points where the Contractor's operations are adjacent to properties of railway, cable, telephone, and power companies, or are adjacent to other property, and any damage to their property may result in considerable expense, loss, or inconvenience, do not commence with the operation until all arrangements necessary for the protection of the property have been made.

Cooperate with the owners of any underground or overhead utility lines in their removal and rearrangement operations to ensure these operations progress in a reasonable manner, that duplication of rearrangement Work may be reduced to a minimum, and that services rendered by those parties will not be unnecessarily interrupted.

In the event interruption to underground or overhead utility services results from an accidental breakage or from being exposed or unsupported, immediately alert the occupants of nearby premises as to any emergency that the accidental breakage may create at or near such premises. Then notify the Engineer and the owner or operator of the utility facility of the disruption and cooperate with the said utility owner or operator in the restoration of service. If water service is interrupted, perform the repair work continuously until the service is restored unless the repair work is performed by the local governmental authority. Do not begin Work around fire hydrants until the local fire authority approves provisions for continued service.

107.17 Furnishing Right-of-Way. The Department is responsible for securing all necessary Right-of-Way in advance of construction. The Bid Documents will indicate any exceptions. The Department will notify all prospective Bidders in writing before the date scheduled for receipt of Bids regarding the specific dates certain parcels will be made available to the Contractor.

107.18 No Waiver of Legal Rights. The following Department actions do not waive the Department's rights or powers under the Contract, or any right to damages herein provided:

A. Inspection by the Engineer or by any of Engineer's duly authorized representatives.

B. Any order, measurements, or certificate by the Director, or Department representatives.

C. Any order by the Director or Department representatives for the payments of money or the withholding of money.

D. Acceptance of any Work.

E. Any extension of time.

F. Any possession taken by the State or its duly authorized representatives.

The Department will not consider any waiver of a breach of this Contract to be a waiver of any other subsequent breach.

107.19 Environmental Protection. Comply with all Federal, State, and local laws and regulations controlling pollution of the environment. Avoid polluting streams, lakes, ponds, and reservoirs with fuels, oils, bitumens, chemicals, sediments, or other harmful materials, and avoid polluting the atmosphere with particulate and gaseous matter.

By execution of this contract, the Contractor, will be deemed to have stipulated as follows:

A. That any facility that is or will be utilized in the performance of this contract, unless such contract is exempt under the Clean Air Act, as amended (42 U.S.C. 1857 et seq., as amended by Pub.L. 91-604), and under the Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et seq., as amended by Pub.L. 92-500), Executive Order 11738, and regulations in implementation thereof (40 CFR 15) is not listed, on the date of contract award, on the U.S. Environmental Protection Agency (EPA) List of Violating Facilities pursuant to 40 CFR 15.20.

B. That the firm agrees to comply and remain in compliance with all the requirements of Section 114 of the Clean Air Act and Section 308 of the Federal Water Pollution Control Act and all regulations and guidelines listed thereunder.

C. That the firm shall promptly notify the Department of the receipt of any communication from the Director, Office of Federal Activities, EPA, indicating that a facility that is or will be utilized for the contract is under consideration to be listed on the EPA List of Violating Facilities.

D. That the firm agrees to include or cause to be included the requirements of paragraph 1 through 4 of this Section in every nonexempt subcontract, and further

agrees to take such action as the government may direct as a means of enforcing such requirements.

Fording of streams is prohibited. Causeways for stream and river crossings or for Work below a bridge are permitted provided:

A. The causeway complies with the requirements of the 404 Permit the Department obtained for the Project.

B. The Contractor obtains a 404 Permit from the U.S. Army Corps of Engineers if the Department has not obtained such a permit. Obtain the 404 Permit prior to beginning construction of the causeway. The Department does not guarantee that the Contractor will be able to obtain a 404 Permit.

Comply with all current provisions of the Ohio Water Pollution Control Act (OWPCA), (ORC Chapter 6111). The Department will obtain a storm water permit under the OWPCA provisions when the plan work acreage requires a permit. Apply for a permit to cover operations outside the Project limits shown on the plans as required by the OWPCA provisions. When the Department has not applied for a permit on the Project and a permit is required under the provisions of the OWPCA because of the total area of the Contractor's work, apply for, obtain, and comply with the required permit for both the Work within Project limits and the Contractor's work.

The Department has obtained the required permits from the U.S. Army Corps of Engineers and Ohio EPA for Work in the "Waters of the United States" and isolated wetlands under ORC Chapter 6111. Comply with the requirements of these permits.

When equipment is working next to a stream, lake, pond, or reservoir, appropriate spill response equipment is required. Do not stockpile fine material next to a stream, lake, pond, or reservoir.

Take precautions to avoid demolition debris and discharges associated with the excavation and hauling of material from entering the stream. Remove any material that does fall into the stream as soon as possible.

When excavating in or adjacent to streams, separate such areas from the main stream by a dike or barrier to keep sediment from entering the stream. Take care during the construction and removal of such barriers to minimize sediment entering the stream.

Contain, collect, characterize and legally dispose of all liquid waste and sludge generated during the work. Do not mix wastes with storm water. Do not discharge any liquid waste without the appropriate regulatory permits. Manage liquid waste and sludge in accordance with ORC Chapter 6111 and all other laws, regulations, permits and local ordinances relating to this waste. Liquid waste management is incidental to the Work unless otherwise specified in the contract.

Control the fugitive dust generated by the Work according to OAC-3745-17-07(B), OAC-3745-17-08, OAC-3745-15-07, and OAC-3745-17-03 and local ordinances and regulations. Prior to the initiation of abrasive coating removal, pavement cutting or any other construction operation that generates dust, demonstrate to the Engineer that construction related dust will be controlled with

appropriate Reasonable Available Control Measures (RACM) as described in OEPA Engineering Guide #57 (http://epa.ohio.gov/dapc/engineer/eguides.aspx).

In addition, use dust control measures when fugitive dust creates unsafe conditions as determined by the Engineer. Perform this work without additional compensation except for Item 616.

Perform open burning according to 105.16.

107.20 Civil Rights. Comply with Federal, State, and local laws, rules, and regulations that prohibit unlawful employment practices including that of discrimination because of race, religion, color, sex, national origin, disability or age and that define actions required for Affirmative Action and Disadvantaged Business Enterprise (DBE) programs.

107.21 Prompt Payment. In accordance with ORC 4113.61, make payment to each subcontractor and supplier within 10 Calendar Days after receipt of payment from the Department for Work performed or materials delivered or incorporated into the Project, provided that the pay estimate prepared by the Engineer includes Work performed or materials delivered or incorporated into the public improvement by the subcontractor or supplier. Contractors are prohibited from holding retainage from subcontractors that can provide a bond. For unbonded subcontractors and suppliers, promptly release any retainage held, as set forth in any subcontractor or supplier agreement, 30 days after the work is satisfactory completed. For the purposes of this section, satisfactory completed will be interpreted as when the subcontractor has completed all physical work and submitted any necessary documentation required by the specifications and the Department. No subcontract provision shall permit the Contractor to delay subcontractor's retainage payments until the Project's final payment.

Also require that this contractual obligation be placed in all subcontractor and supplier contracts that it enters into and further require that all subcontractor and suppliers place the same payment obligation in each of their lower tier contracts. If the Contractor, subcontractors, or supplier subject to this provision fail to comply with the 10 Calendar Day requirement, the offending party shall pay, in addition to the payment due, interest in the amount of 18 percent per annum of the payment due, beginning on the eleventh Calendar Day following the receipt of payment from the Department and ending on the date of full payment of the payment due plus interest.

Repeated failures to pay subcontractors and suppliers timely pursuant to this subsection will result in a finding by the Department that the Contractor is in breach of Contract and subject to all legal consequences that such a finding entails. Further, repeated failures to pay timely pursuant to this subsection will result in a lower evaluation score for the Contractor and those subcontractors who are subject to evaluation by the Department.

107.22 Unmanned Aircraft Systems. If the project requires or anticipates the use of Unmanned Aircraft Systems within ODOT Right of Way, the Contractor will follow proper risk assessment and federal regulations in accordance with Supplement 1132.

108 PROSECUTION AND PROGRESS

108.01 Subletting of the Contract. Perform Work amounting to not less than 50 percent of the Contract Price with its own organization, unless otherwise approved by the Director. The phrase "its own organization" includes only workers employed and paid directly, inclusive of employees who are employed by a lease agreement acceptable to the Department, and equipment owned or rented with or without operators by the Contractor. The phrase does not include employees or equipment of a subcontractor, assignee, or agent of the Contractor. Obtain the Director's written consent to subcontract, sublet, sell, transfer, assign, or otherwise relinquish rights, title, or interest in the Work. Provide the Director with a copy of all Disadvantaged Business Enterprise subcontracts.

The Contractor's percentage of the total Contract Price includes the cost of materials and manufactured products purchased by the Contractor, but not the cost of materials and manufactured products purchased by subcontractors.

The Director will calculate the Contractor's percentage based on the quantities shown in the Proposal and the unit prices of the contract items to be performed by the Contractor's organization. If the Contractor performs only a portion of a contract item, then the Director will determine the proportional value administratively on the same basis. The Director will follow this procedure even when the part not subcontracted consists only of the procurement of materials. However, if a firm both sells the materials to the Contractor and performs the Work of incorporating the materials into the Project, then the Department will consider these two phases in combination and as a single subcontract. If an affiliate of the firm either sells the materials or performs the Work, the Department may refuse approval. An affiliate is one who has some common ownership or other close relation to said firm.

Use actual subcontract prices for calculating compliance with any Disadvantaged Business Enterprise (DBE) percentage subcontracting obligations. If only a part of a contract item is sublet, then determine its proportional value administratively on the same basis. The Director will follow this procedure even when the part not sublet consists only of procuring materials. However, if a firm both sells the materials to the Contractor and performs the work of incorporating the materials into the Project, then the Department will consider these two phases in combination and as a single subcontract. If an affiliate of the firm either sells the materials or performs the Work, the Department may refuse approval.

108.02 Partnering. It is the intent of the Department to partner every project. The purpose of Partnering is to develop a proactive effort and spirit of trust, respect, and cooperation among all stakeholders in a project. Partnering does not affect the terms and conditions of the Contract. The Partnering process in this section is Self-facilitated Partnering performed by the Project personnel. Costs associated with the Self-facilitated Partnering process are incidental to the Contract.

A. Preconstruction Meeting. Meet with the Engineer for a Preconstruction Meeting before beginning the Work. At or before the meeting, submit the initial progress schedule to the DCE. Prepare the schedule according to 108.03.

Furnish a list of proposed subcontractors and material suppliers at or before the Preconstruction Meeting. If the Contractor fails to provide the required

submissions at or before the Preconstruction Meeting, the Engineer may order the meeting suspended until they are furnished. Do not begin the Work until the meeting is reconvened and concluded or the Engineer gives specific written permission to proceed.

B. Initial Partnering Session. In conjunction with the Engineer, determine whether the Initial Partnering Session will be conducted as part of the Preconstruction Meeting or as a separate meeting. Partnering shall have its own agenda with specific time set aside to develop the necessary partnering protocols. Develop the Partnering agenda with the Engineer.

Identify and invite all stakeholders necessary to make the Project successful including utility companies, other transportation entities (i.e., railroads), community leaders, all Project participants including subcontractors.

During the Initial Partnering Session, consider developing Partnering teams consisting of Department and Contractor senior personnel and Project personnel. Consider the following items for discussion:

1. Identifying and developing a consensus on project goals consistent with the contractual obligations, including specific goals concerning safety, quality, schedule, and budget.

2. Deciding how the teams will measure progress on Project goals.

3. Identifying any potential risks to the Project's success, mitigation strategies and an implementation plan for the appropriate strategies.

4. Defining key issues, project concerns, joint expectations, roles of key partnership leaders, lines of decision making authority, and share relevant information to help determine the scope of the Partnering efforts.

5. Identifying any opportunities for project enhancement, enhancement strategies and a specific action plan for implementing strategies.

6. Developing a communication protocol to enhance communication on the Project

7. Developing an issue identification and resolution process that identifies and attempts to resolve issues at the level closest to the work. The issue identification and resolution process will develop all the necessary steps for issue elevation including Notice and Mitigation defined in 108.02.F and the Dispute Resolution and Administrative Claims Process defined in 108.02.G.

8. On-line surveys of Project participants may be used to evaluate Project goals and help identify issues either before or immediately after the Initial Partnering Session. The on-line survey is located on the Division of Construction Management's Partnering website:

www.dot.state.oh.us/Divisions/ConstructionMgt/Pages/Partnering.aspx

C. Progress Meetings. Hold monthly Progress Meetings unless the frequency is otherwise determined at the Preconstruction Meeting. Coordinate with the Engineer to determine agenda topics prior to each meeting. The purpose of Progress Meetings is to keep open communication between the Contractor and the Engineer. The senior

personnel team is encouraged to participate in all Progress Meetings. Include Partnering as an agenda item at the Progress Meetings.

D. Post-milestone Meeting. In conjunction with the Engineer, determine whether the Post-milestone Meeting will be conducted as part of the Progress Meeting or as a separate meeting for multi-year, multi-phase, or projects with critical items of work or milestone dates. Consider discussing and updating items from the Initial Partnering Session in addition to items specific to the Project. All stakeholders should be invited to attend.

E. Partnering Monitoring. Monitor the progress of the Partnering relationship based on the goals decided during the Initial Partnering Session. On-line surveys of Project participants may be used to monitor progress on Project goals and help identify issues as they arise. The on-line survey is located on the Division of Construction Management's Partnering website:

www.dot.state.oh.us/Divisions/ConstructionMgt/Pages/Partnering.aspx

F. Mitigation and Notice. Mitigation of any issue, whether caused by the Department, Contractor, third-party or an intervening event, is a shared contract and legal requirement. Mitigation efforts include, but are not limited to, re-sequencing work activities, acceleration, and substitution of materials. The Contractor and Engineer must explore and discuss potential mitigation efforts in a timely manner.

1. Contractor Initial Oral Notification. Provide immediate oral notification to the Engineer upon discovering a circumstance that may require a revision to the Contract Documents or may result in a dispute. Upon notification, the Engineer will attempt to resolve the identified issue as quickly as possible.

2. Contractor Written Early Notice. If the Engineer has not resolved the identified issue within two (2) working days after receipt of oral notification, provide written notice to the Engineer of any circumstance that may require a revision to the Contract Documents or may result in a dispute. This early notice must be given by the end of the second working day following the occurrence of the circumstance.

The Engineer and Contractor shall maintain records of labor, equipment, and materials used on the disputed work or made necessary by the circumstance. Such records will begin when early notice is received by the Engineer. Tracking such information is not an acknowledgement that the Department accepts responsibility for payment for this disputed work.

If an issue is not resolved through the initial mitigation efforts, either abandon or escalate to the Dispute and Administrative Claims Process defined in 108.02.G.

G. Dispute Resolution and Administrative Claims Process. Whenever an issue is elevated to a dispute, the parties shall exhaust the Department's Dispute Resolution and Administrative Claim process set forth below as a condition precedent to filing an action in the Ohio Court of Claims. The following procedures do not otherwise compromise the Contractor's right to seek relief in any Ohio Court with legal jurisdiction.

All parties to the dispute must adhere to the Dispute Resolution and Administrative Claim process. Do not contact Department personnel who are to be

involved in a Step 2 or Step 3 review until a decision has been issued by the previous tier. Department personnel involved in Step 2 or Step 3 reviews will not consider a dispute until the previous tier has properly reviewed the dispute and issued a decision.

Failure to meet any of the timeframes outlined below or to request an extension will terminate further review of the dispute and serve as a waiver of the Contractor's right to file a claim.

Disputes and claims by subcontractors and suppliers may be pursued by the Contractor on behalf of subcontractors or suppliers. Disputes and claims by subcontractors and suppliers against the Department but not supported by the Contractor will not be reviewed by the Department. Disputes and claims of subcontractors and suppliers against the Contractor will not be reviewed by the Department.

Continue with all Work during the Dispute Resolution and Administrative Claims process, including that which is in dispute. The Department will continue to pay for Work.

The Department will not make the adjustments allowed by 104.02.B, 104.02.C, and 104.02.D if the Contractor did not give notice as specified in 108.02.F.1 and 108.02.F.2. This provision does not apply to adjustments provided in Table 104.02-2.

1. Step 1 (On-Site Determination). The Engineer will meet with the Contractor's superintendent within two (2) working days of receipt of the Contractor Written Early Notice set forth in 108.02.F.2. They will jointly review all pertinent information and contract provisions and negotiate in an effort to reach a resolution. The Engineer will issue a written Step 1 decision within fourteen (14) calendar days of the meeting. If the dispute is not resolved, either abandon or escalate the dispute to Step 2.

2. Step 2 (District Dispute Resolution Committee). Each District will establish a District Dispute Resolution Committee (DDRC) which will be responsible for hearing and deciding disputes at the Step 2 level. The DDRC will consist of the District Deputy Director, District Construction Engineer and the Capital Program Administrator or designees (other than the project personnel involved in the dispute).

Within seven (7) calendar days of receipt of the Step 1 decision, either abandon the dispute or submit a written request for a Step 2 meeting to the District Construction Engineer (DCE). The DCE will assign the dispute a dispute number. Within fourteen (14) calendar days of submitting the request for a Step 2 meeting, submit three (3) complete copies of the Dispute Documentation to the DCE as follows:

a) Identify the Dispute on a cover page by county, project number, Contractor name, subcontractor or supplier if involved in the dispute, and the dispute number.

b) Clearly identify each item for which additional compensation and/or time is requested.

c) Provide a detailed narrative of the disputed work or project circumstance at issue. Include the dates of the disputed work and the date of early notice.

d) Reference the applicable provisions of the plans, specifications, proposal, or other contract documents in dispute. Include copies of the cited provisions in the Dispute Documentation.

e) Include the dollar amount of additional compensation and length of contract time extension requested.

f) Include supporting documents for the requested compensation stated above.

g) Provide a detailed schedule analysis for any dispute involving additional contract time, actual or constructive acceleration, or delay damages. At a minimum, this schedule analysis must include the Schedule Update immediately preceding the occurrence of the circumstance alleged to have caused delay and must comply with accepted industry practices. Failure to submit the required schedule analysis will result in the denial of that portion of the Contractor's request.

h) Include copies of relevant correspondence and other pertinent documents.

Within fourteen (14) calendar days of receipt of the Contractor's Dispute Documentation, the Engineer will provide the Contractor with all documentation it intends to rely on at the DDRC meeting to rebut the Contractor's dispute.

After allowing at least fourteen (14) calendar days for the Contractor to review the Engineer's Dispute Documentation, the DDRC will conduct the Step 2 meeting with Contractor personnel who are authorized to resolve the dispute. The DDRC will issue a written Step 2 decision to the Contractor and the Dispute Resolution Coordinator within fourteen (14) calendar days of the meeting. If the dispute is not resolved, either abandon or escalate the dispute to Step 3.

3. Step 3 (Director's Claims Board Hearing or Alternative Dispute Resolution). Submit a written Notice of Intent to File a Claim to the Dispute Resolution Coordinator in the Division of Construction Management within fourteen (14) calendar days of receipt of the Step 2 decision. The dispute becomes a claim when the Dispute Resolution Coordinator receives the Notice of Intent to File a Claim. Include the Contractor's request for either: 1) a Director's Claim Board hearing on the claim or 2) Alternative Dispute Resolution (ADR).

a) Director's Claims Board Hearing. The Director's Claims Board (the "Board") will consist of the Deputy Director of the Division of Construction Management, Deputy Director of Engineering and a District Capital Program Administrator from a district not involved in the claim, or their designees. A representative from the Division of Chief Legal Counsel and Division of Opportunity, Diversity, and Inclusion may be present to observe the hearing. The Director or designee will be responsible for deciding claims.

(1) Submit six (6) complete copies of the Claim Documentation to the Dispute Resolution Coordinator within thirty (30) calendar days of receipt of

the Notice of Intent to File a Claim. This timeframe may be extended with approval of the Dispute Resolution Coordinator.

In addition to the documentation submitted at Step 2:

(a) Enhance the narrative to include sufficient description and information to enable understanding by a third party who has no knowledge of the dispute or familiarity with the project.

(b) Certify the claim in writing and under oath using the following certification:

"I, (Name and Title of an Officer of the Contractor) certify that this claim is made in good faith, that all supporting data is accurate and complete to the best of my knowledge and belief, and that the claim amount accurately reflects the contract amendment for which (Contractor Company name) believes the Department is liable."

Sign and date this claim certification and have the signature notarized pursuant to the laws of the State of Ohio. The date the Dispute Resolution Coordinator receives the certified claim documentation is the date of the Department's Receipt of the Certified Claim for the purpose of the calculation of interest as defined in 108.02.G.4. The Dispute Resolution Coordinator will forward one (1) complete copy of this documentation to the District.

(2) Within thirty (30) calendar days of the District's receipt of the Contractor's Claim Documentation, the District will submit six (6) complete copies of its Claim Documentation to the Dispute Resolution Coordinator. This timeframe may be extended with approval from the Dispute Resolution Coordinator. At a minimum, the District's Claim Documentation should include:

(a) An overview of the project

(b) A narrative of the disputed work or project circumstance at issue with sufficient description and information to enable understanding by a third-party who has no knowledge of the dispute or familiarity with the project

(c) The dates of the disputed work and the date of early notice

(d) References to the applicable provisions of the plans, specifications, proposal, or other contract documents. Copies of the cited provisions shall be included in the claim document

(e) Response to each argument set forth by the Contractor

(f) Any counterclaims, accompanied by supporting documentation, the District wishes to assert

(g) The status of the negotiations of the Claim that have occurred to-date, including the amount of any offers and counteroffers made by the parties

(h) Copies of relevant correspondence and other pertinent documents

(3) Within fourteen (14) calendar days of receipt of the District's Claim Documentation, the Dispute Resolution Coordinator will forward one (1) complete copy to the Contractor and will schedule a hearing on the dispute.

Once a hearing date has been established, both the Contractor and District shall provide the Dispute Resolution Coordinator with a list of names of persons who may be presenting information at the hearing. Unless otherwise permitted by the Board, the exchange of documentation and all disclosures specified in this step of the process shall be completed at least fourteen (14) calendar days prior to the hearing.

Upon request or at the Board's discretion, the Board may delay the hearing to allow more time for preparation and review, or to fulfill requests for more documentation.

The Board will hear the entire claim on behalf of the Director. The Board may have its own technical advisors at the hearing for consultation and assistance in reviewing the claim. The Contractor and District will each be allowed adequate time to present their respective positions before the Board. The Contractor and District will also each be allowed adequate time for rebuttal, limited to the scope of the opposing party's presentation. The Board may suspend any portion of a presentation or rebuttal it deems to be argumentative, repetitive, or irrelevant to the claim. The Contractor's position will be presented by one or more of the Contractor's employees who are thoroughly knowledgeable of the claim. The Contractor may have legal counsel present during the hearing to observe or for private consultation. Similarly, the District's position will be presented by one or more District representatives who are thoroughly knowledgeable of the claim.

The Board may, on its own initiative, request information in addition to that submitted for the hearing. If the Contractor fails to reasonably comply with such request, the Board may render its decision without such information.

Upon completion of the hearing and following consideration of any additional information submitted upon request, the Board will submit a written recommendation on the disposition of the claim to the Director. The Director or designee will ratify, modify, or reject the recommendation of the Board and render a decision within sixty (60) calendar days of the hearing. Within thirty (30) calendar days of receipt of the Board's decision, either accept or reject the decision in writing. In the event the Contractor fails to do so, the Board may revoke any offers of settlement contained in the decision.

The decision of the Director is the final step of the Department's Dispute Resolution Process and may not be appealed within the Department. The Director is not bound by any offers of settlement or findings of entitlement made during Steps 1 and 2 of the Dispute Resolution Process.

b) Alternative Dispute Resolution (ADR). In lieu of the Director's Claim Board hearing, the parties may opt to proceed through an Alternative Dispute Resolution (ADR) Process. The parties will then choose either arbitration or

mediation in the manner in which those methods are practiced by the Department and allowed by law.

The Dispute Resolution Coordinator will coordinate the agreement of the parties to the ADR method, and the selection of a neutral third-party or technical expert. The fees of the neutral third-party or technical expert will be shared equally between the Department and the Contractor. The Dispute Resolution Coordinator will obtain a written agreement, signed by both parties, that establishes the ADR process. The neutral third-party or technical expert will have complete control of the claim upon execution of the ADR agreement.

Prior to any ADR meeting, certify the claim in writing and under oath using the following certification:

"I, (Name and Title of an Officer of the Contractor) certify that this claim is made in good faith, that all supporting data is accurate and complete to the best of my knowledge and belief, and that the claim amount accurately reflects the contract amendment for which (Contractor Company name) believes the Department is liable."

4. Interest on Claims. The Department will pay interest in accordance with ORC Section 5703.47 on any amount ultimately found due on a claim which is not paid within 30 days of the Dispute Resolution Coordinator's Receipt of the Certified Claim. However, interest will not be paid on the amount of any agreed settlement unless specifically itemized and included in the total settlement prior to agreement.

H. Post Construction Meeting. The District will conduct a Post Construction Meeting with the Contractor prior to the project finalization. The District will invite the design agency and any other stakeholders deem necessary including utility companies, other transportation entities (i.e. railroads), community leaders, all Project participants including subcontractors performing critical work to attend this meeting.

Consider the following items for discussion:

1. Project Safety.
2. How were the goals evaluated or measured?
3. How were foremen/ workers involved in the Partnering process?
4. How were the subcontractors involved in the Partnering process?
5. How were relationships with key stakeholders managed?
6. Teambuilding activities or unique motivational activities.

I. Partnering Close-Out Survey. On-line surveys of Project participants may be used to get participants' feedback and improve the Partnering process. The Partnering Close-Out Survey is located on the Division of Construction Management's Partnering website:

www.dot.state.oh.us/Divisions/ConstructionMgt/Pages/Partnering.aspx

108.03 Prosecution and Progress. Start the Work according to 108.02. Notify the Engineer at least 24 hours before starting the Work. If the prosecution of the

Work is suspended, notify the Engineer a minimum of 24 hours in advance of resuming operations.

Pursue the Work diligently and continuously as to complete the Project by the Completion Date.

A. Progress Schedule.

1. General. Furnish a bar chart progress schedule to the District Construction Engineer for review at or before the Preconstruction Meeting. The Engineer will review the schedule and within 14 calendar days of receipt, will either accept the schedule or provide the Contractor with comments. Acceptance of the schedule does not revise the Contract Documents. Provide clarification or any needed additional information within 10 days of a written request by the Engineer. The Department will withhold Estimates until the Engineer accepts the schedule. The Engineer will not measure or pay for the preparation of the schedule and schedule updates directly, but the cost of preparing and updating the schedule is incidental to all Contract Items.

a. Include the following Administrative Identifier Information:

(1) Project Number
(2) County
(3) Route Number
(4) FHWA Number
(5) PID Number
(6) Contract Number
(7) Date of Contract
(8) Completion Date
(9) Contractor's Name
(10) Contractor's Dated Signature
(11) ODOT's Dated Acceptance Signature

Provide a working day schedule that shows the various activities of Work in sufficient detail to demonstrate a reasonable and workable plan to complete the Project by the Completion Date. Show the order and the sequence for accomplishing the Work. Describe all activities in sufficient detail so that the Engineer can readily identify the Work and measure the progress of each activity. The bar chart schedule must reflect the scope of work, required phasing, maintenance of traffic requirements, interim completion dates, the Completion Date, and other project milestones established in the Contract Documents. Include activities for submittals, working and shop drawing preparation, submittal review time for the Department, material procurement and fabrication, and the delivery of materials, plant, and equipment, and other similar activities. The schedule must be detailed on letter or legal sized paper.

b. Activity requirements are discussed in further detail as follows:

(1) Activity Description. Assign each activity an unambiguous descriptive word or phrase. For example, use "Excavate Area A," not "Start Excavation."

(2) Activity Original Duration. Indicate a planned duration in calendar days for each activity. Do not exceed a duration of 20 working days for any activity unless approved by the Engineer. Do not represent the maintenance of traffic, erosion control, and other similar items as single activities extending to the Completion Date. Break these Contract Items into component activities in order to meet the duration requirements of this paragraph.

2. Early Completion Schedule. An Early Completion Schedule is defined as a baseline schedule or update schedule which anticipates completion of all work prior to the Completion Date established by the contract documents and the Contractor submits as an Early Completion Schedule. In the event that an Early Completion Schedule is accepted, the Engineer will initiate a change order amending the Completion Date to the finish date shown on the accepted Early Completion Schedule. The amended Completion Date will be effective upon execution of that change order and all contract provisions concerning the Completion Date such as incentives, disincentives, excusable delays, compensable delays, and liquidated damages will be measured against the amended Completion Date. The Contractor may elect not to execute the change order amending the Completion Date; however, in so doing, the Contractor waives its rights to delay damages in meeting the projected early Completion Date.

3. Updated Progress Schedule. Submit an updated progress schedule when ordered by the Engineer. The Engineer may request an updated progress schedule when progress on the work has fallen more than 14 calendar days behind the latest accepted progress schedule. Information in the updated schedule must include a "% work completed" value for each activity.

4. Recovery Schedule. If the progress schedule projects a finish date for the Project more than 14 calendar days later than the Completion Date, submit a revised schedule showing a plan to finish by the Completion Date. The Department will withhold Estimates until the Engineer accepts the revised schedule. The Engineer will use the schedule to evaluate time extensions and associated costs requested by the Contractor.

108.04 Limitation of Operations. Limit operations to prevent unnecessary inconvenience to the traveling public. If the Engineer concludes that the extent of the Contractor's Work unnecessarily inconveniences the public or concludes limiting operations are necessary to protect the existing or new construction from damage, the Engineer will require the Contractor to finish portions of Work in progress before starting new Work.

108.05 Character of Workers Methods and Equipment. Provide personnel with sufficient skills and experience to perform assigned tasks.

Ensure that no debarred individuals listed on the Federal website: www.epls.gov or State debarment list at the website: www.dot.state.oh.us/divisions/contractadmin/ act in any ownership, leadership, managerial, or other similar position that could influence the operations of an entity doing business with the Department.

If the Engineer gives written notification that specific Contractor or subcontractor personnel are improperly performing the Work, intemperate, disorderly, or creating a hostile work environment, remove the identified personnel from the Project. Do

not allow removed personnel to return to the Project without the Engineer's approval.

The Engineer may suspend the Work by written notice under this subsection for the following reasons:

A. The Contractor does not furnish sufficient skilled and experienced personnel to complete the Project by the Completion Date.

B. The Contractor does not remove personnel from the Project as directed in writing by the Engineer.

Use equipment of sufficient size and mechanical condition to complete the Project by the Completion Date. Ensure that the equipment does not harm the roadway, adjacent property, other highways, workers, or the public.

If the Contract Documents do not prescribe the methods and equipment required to accomplish the Work, determine the methods or equipment necessary to complete the Work according to the Contract.

If the Contract Documents specify methods and equipment to perform the Work, use such methods and equipment, unless others are authorized by the Engineer. Obtain the Engineer's written approval before substituting alternate methods or equipment. To obtain the Engineer's approval, submit a written description of the alternate methods and equipment proposed and an explanation of the reasons for making the change. The Engineer's approval of the substitute methods and equipment does not relieve the Contractor of the obligation to produce Work according to 105.03. If after trial use of the substituted methods or equipment, the Engineer determines that the Work does not conform to the Contract Documents, then complete the remaining Work using the specified methods and equipment. Remove all deficient Work and replace it according to the Contract Documents, or take such other corrective action as directed by the Engineer. The Engineer's authorization to substitute alternate methods and equipment will not change the basis of payment for the construction items involved or the Contract Time.

108.06 Determining a Time Extension to the Completion Date and Payment for Excusable Delays.

A. General. The Department will only extend the Completion Date if an excusable delay, as specified in 108.06.B or 108.06.D, delays Work on the critical path shown on the accepted progress schedule and impacts the Completion Date. The critical path is defined as; the longest path of activities in the project that determines the project schedule completion date. The activities that make-up the critical path of activities are the "Critical Activities." Any extension of the Completion Date will be executed by a change order.

Mitigation of any delay, whether caused by the Department, Contractor, third-party or an intervening event, is a shared contract and legal requirement. Mitigation efforts include, but are not limited to, re-sequencing work activities, acceleration, and continuation of work through an otherwise planned shutdown period. The Contractor and Engineer must explore and discuss potential mitigation efforts in a timely manner.

The Department will not evaluate a request for extension of the Completion Date unless the Contractor notifies the Engineer as specified in 108.02.F. Notification shall be in writing to the Engineer within 30 days following the termination of the event giving rise to the request and shall be accompanied by supporting analysis and documentation.

The Engineer will evaluate the Contractor's analysis and determine the time extension due, if any. The Engineer will measure all time extensions in Calendar Days. For delays measured in Workdays, the Engineer will convert Workdays to Calendar Days by multiplying by 1.4 for a 5-day work week or less; 1.2 for a 6-day work week; and 1 for a 7-day work week; and extend the Completion Date by the resulting number of Calendar Days plus any holidays the Contractor does not normally work that occur in the extension period. When the conversion of Workdays to Calendar Days results in a decimal of 0.5 or greater, the Engineer will round the number of Calendar Days to the next highest whole number. When the conversion results in a decimal less than 0.5, the Engineer will delete the decimal portion of the Calendar Days.

The Engineer will not grant an extension of time for delays incurred from December 1 to April 30 unless the Contractor's accepted progress schedule depicts work on the critical path occurring during this period.

The Engineer may order the Contractor to continue Work after November 30 and compensate the Contractor for costs incurred due to cold weather Work.

The Contractor's plea that insufficient time was specified is not a valid reason for an extension of time.

The Department will relieve the Contractor from associated liquidated damages, as specified in 108.07, if the Engineer extends the Completion Date under 108.06.A.

The extended Completion Date shall then have the same standing and effect as though it was the original Completion Date.

If the Contractor contends that an excusable delay is also compensable, as specified in 108.06.D, submit a detailed cost analysis of the requested additional compensation along with the request for extension of Completion Date.

B. Excusable, Non-Compensable Delays. Excusable, non-compensable delays are delays that are not the Contractor's or the Department's fault or responsibility. The Engineer will not grant additional payment for excusable, non-compensable delays.

The following are excusable, non-compensable delays:

1. Delays due to floods, tornadoes, lightning strikes, earthquakes, or other cataclysmic phenomena of nature.

2. Delays due to weather as specified in 108.06.C.

3. Extraordinary delays in material deliveries the Contractor or its suppliers cannot foresee or avoid resulting from freight embargoes, government acts, or area-wide material shortages. Delays due to the Contractor's, subcontractor's, or supplier's insolvency or mismanagement are not excusable.

4. Delays due to civil disturbances.

5. Delays from fires or epidemics.

6. Delays from labor strikes that are beyond the Contractor's, subcontractor's, or supplier's power to settle and are not caused by improper acts or omissions of the Contractor, subcontractor, or supplier.

7. Added quantities that delay an activity on the critical path.

8. All other delays not the Contractor's and Department's fault or responsibility.

C. Extension to the Completion Date for Weather or Seasonal Conditions. A weather day is defined as a workday that weather or seasonal conditions reduced production by more than 50 percent on items of work on the critical path. Submit the dates and number of weather days in writing to the Engineer at the end of each month. In the event the Contractor fails to submit weather days at the end of each month the Engineer will determine the dates and number of weather days from project records.

Delays caused by weather and seasonal conditions should be anticipated and will be considered as the basis for an extension of time when the Contractor's accepted progress schedule depicts Work on the critical path and the actual workdays lost exceeds the number of work days lost each month as determined by Table 108.06-1.

TABLE 108.06-1

Month	Number of Workdays Lost Due to Weather
January	8
February	8
March	7
April	6
May	5
June	5
July	4
August	4
September	5
October	6
November	6
December	6

This table applies to the duration between contract execution and original completion date. Extensions for weather days beyond the original completion date will be for the actual workdays lost each month.

Lane closures within the project, 60 days or less as indicated in the contract documents, which are impacted by weather will be extended for the actual work days lost each month. Lane closures within the project, 61 days or longer as indicated in the contract documents, which are impacted by weather will be extended when the actual work days lost exceeds the number of anticipated work days lost each month as determined by Table 108.06-1.

The Engineer will not consider weekends and holidays as lost workdays unless the Contractor normally works those days or unless the Engineer directs the Contractor to work those days.

D. Excusable, Compensable Delays. Excusable, compensable delays are delays that are not the Contractor's fault or responsibility, and are the Department's fault or responsibility or are determined by judicial proceeding to be the Department's sole responsibility or are the fault and responsibility of a local government. For the following excusable, compensable delays, the Engineer will extend the Completion Date if the conditions specified in 108.06.A are met:

1. Delays due to revised Work as specified in 104.02.B, 104.02.D, or 104.02.F.

2. Delays due to utility or railroad interference within the Project limits.

3. Delays due to an Engineer-ordered suspension as specified in 104.02.C.

4. Delays due to acts of the government or a political subdivision other than the Department.

5. Delays due to the neglect of the Department or its failure to act in a timely manner.

Compensation for excusable, compensable delays will be determined by the Engineer according to 109.05.D.

E. Non-Excusable Delays. Non-excusable delays are delays that are the Contractor's fault or responsibility. All non-excusable delays are non-compensable.

F. Concurrent Delays. Concurrent delays are separate critical delays that occur at the same time. When a non-compensable delay is concurrent with a compensable delay, the Contractor is entitled to additional time but not entitled to additional compensation.

108.07 Failure to Complete on Time. If the Contractor fails to complete the Work by the Completion Date, then the Director, if satisfied that the Contractor is making reasonable progress, and deems it in the best interest of the public, may allow the Contractor to continue in control of the Work. The Department will pay the Contractor for Work performed on the Project less any liquidated damages incurred.

If the Work is not completed by the Completion Date and the Director permits the Contractor to remain in control, prosecute the Work at as many different places, at such times, and with such forces as the Director requests. Provide a written plan for the completion of the Work.

For each calendar day that Work remains uncompleted after the Completion Date, the Department will deduct the sum specified herein from any money due the Contractor, not as a penalty, but as liquidated damages. The Director will adjust the Completion Date or other contractually mandated dates for delays specified in 108.06.B.7 and 108.06.D.

Permitting the Contractor to continue and complete the Work or any part of the Work after the Completion Date, or after extensions to the Completion Date, will in

no way operate as a waiver on the part of the Department of any of its rights under the Contract.

Provided the project is available for use as intended by the Contract and the Work remaining will not impact traffic, the Contractor may submit a request that the Department suspend the assessment of liquidated damages for a stated period of time. For the limited purposes of assessing liquidated damages, the closing of a shoulder is not considered an impact upon traffic. Submit this request within 30 days of the assessment of the liquidated damages. In addition to the written plan required to remain in control of the Work as stated above, this request should include at a minimum the Work left to be completed, the reason(s) the Work is incomplete or on hold, as well as, methods, resources and timelines for pursuing the same. This will define diligent pursuit of the work. Once accepted, and provided both of the following criteria are met, the Department may suspend the assessment of liquidated damages:

A. The Contractor is diligently pursuing the remaining Work.

B. Necessary items are completed and operational to provide an appropriate level of safety to the traveling public. These items include but are not limited to signs, pavement markings, guardrail, attenuators, signals and RPM's.

TABLE 108.07-1 SCHEDULE OF LIQUIDATED DAMAGES

Original Contract Amount (Total Amount of the Bid)		Amount of Liquidated Damages to be Deducted for each Calendar Day of Overrun in Time
From More Than	To and Including	
$0.00	$500,000	$400
$500,000	$2,000,000	$600
$2,000,000	$10,000,000	$900
$10,000,000	$50,000,000	$1,650
Over $50,000,000		$3,970

108.08 Unsatisfactory Progress and Default of Contractor. The Director will notify the Contractor in writing of unsatisfactory progress for any of the following reasons:

A. The Contractor has not commenced the Work by the dates established in the schedule.

B. The Contractor does not proceed with the Work in a manner necessary for completion of the Project by the Completion Date.

C. The Contractor is performing the Work improperly.

D. The Contractor abandons, fails, or refuses to complete the Work.

E. Any other reason the Director believes jeopardizes completion of the Work by the Completion Date.

If the Contractor does not respond to the satisfaction of the Director, the Director may declare the Contractor in default and may notify the Contractor and Surety that the responsibility to complete the Work is transferred to the Surety. Upon receipt of this notification, the Contractor's right to control and supervise the Work will immediately cease. In such a case, the Director will proceed as specified in ORC

5525.17. The defaulted Contractor will not be compensated for costs resulting from the default and is not eligible to be retained by the Surety to complete the Work. If it is determined that the Department's default of the Contractor according to 108.08 is wrongful, then the default will revert to a termination of the Contract according to 108.09.

108.09 Termination of the Contract for Convenience of the Department. The Director may terminate the Contract at any time for the convenience of the Department. The Department will compensate the Contractor according to 109.04 and 109.05 for termination of the Contract for the convenience of the Department. This subsection is subject to the provisions of ORC 5525.14.

108.10 Payroll Records. Keep payroll records as specified in ORC 4115.07 or as required by Federal law.

Authorized representatives of the Director may inspect the certified payroll and other payroll records. Upon completion of the Work and before receiving the final estimate and when required by ORC 4115.07, submit an affidavit stating that wages have been paid according to the minimum rates specified in the Contract Documents.

109 ACCEPTANCE, MEASUREMENT, AND PAYMENT

109.01 Measurement of Quantities. The Department will measure the quantities of Work and calculate payments based on the method of measurement and basis of payment provisions provided in these Specifications. When the following units of measure are specified, the Department will measure quantities as described below unless otherwise specified in the Contract Documents. The accuracy for both Daily Diary payment and Final Quantity payment will be in accordance with Supplement 1133.

Lump Sum. Not measured. Describes payment as reimbursement for all resources necessary to complete the Work. When a complete structure or structural unit is specified as the unit of measurement, the unit will include all necessary fittings and accessories.

Each. Measured by the number of individual items of Work completed.

Foot (Meter). Measured parallel to the longitudinal base or foundation upon which items are placed, or along the longitudinal surface of the item. Measured vertically to the nearest 0.1 foot (0.01 m), with a minimum vertical measurement of 1 foot (0.10 m), at each unit.

Square Yard or Square Foot (Square Meter). Measured by a two-dimensional area method on the surface of the item.

M Square Feet. One thousand square feet.

Cubic Yard (Cubic Meter). Measured by a three-dimensional volume method. Measure all "loose material" or material "measured in the vehicle" by the cubic yard (cubic meter). Haul material "measured in the vehicle" in approved vehicles and measure in the vehicle at the point of delivery. For this purpose, use approved vehicles of any type or size satisfactory to the Engineer, provided the vehicle's bed is of such type that the actual contents are readily and accurately determined. Unless

all approved vehicles on a job are of uniform capacity, each approved vehicle must bear a legible identification mark indicating the specific approved capacity. The Inspector may reject all loads not hauled in such approved vehicles.

Cubic Yard (Cubic Meter) for Asphalt Concrete. Measure as specified in 401.12.

Acre (Hectare). Measured by a two-dimensional area method on the surface to the nearest 0.1 acre (0.05 ha).

Pound (Kilogram). Measured by actual item net weight avoirdupois (mass).

Ton (Metric Ton). The term "ton" means the short ton consisting of 2000 pounds avoirdupois. The term "metric ton" means 1000 kilograms. Weigh all materials that are proportioned by weight on accurate and approved scales that are operated by competent, qualified personnel at locations approved by the Engineer. However, car weights will not be acceptable for materials to be passed through mixing plants. If trucks are used to haul material being paid for by weight, weigh the empty truck at least once daily and as the Engineer directs and only if the weight of the truck is used in determining the ticket weight. Place a plainly legible identification mark on each truck bearing the weight of the truck.

For Work on a tonnage basis, file with the Engineer receipted freight bills for railroad shipments and certified weight-bills when materials are received by any other method, showing the actual tonnage used. For Work on a volume basis, itemize evidence of the volume used.

Gallon (Liter). Measured by actual item liquid volume. The Department will measure the following materials by the gallon (liter) at the following temperatures:

Temperatures	Items
60 °F (16 °C)	Creosote for Priming Coat, Creosote Oil, Creosote Solutions for Timber Preservatives, Asphalt Primer for Water-proofing, and Liquefier
100 °F (38 °C)	RC, MC Asphalt Emulsions, CBAE, Primer 20, and Primer 100
300 °F (149 °C)	Asphalt Binder

Measure tank car outage of asphalt material at its destination before any material has been removed from the tank car according to Supplement 1060.

Convert the net weight of asphalt material shipments to gallons (liters) at the specified pay temperature according to Supplement 1060.

Convert the gallons (liters) at the measured temperature to gallons (liters) of asphalt material at the specified pay temperature according to Supplement 1060.

M Gallon. One thousand gallons.

Thousand Board Feet, MBF (Cubic Meter). Measure timber by MBF (cubic meter) actually incorporated in the structure. Base the measurement on nominal widths, thicknesses, and the extreme length of each piece.

Standard Manufactured Items. When standard manufactured items are specified such as fence, wire, plates, rolled shapes, pipe conduit, etc., and these items

are identified by size, unit weight, section dimensions, etc., such identification will be to nominal weights or dimensions set by the industry.

109.02 Measurement Units. The Department will measure using either English or metric units as indicated in the Contract Documents. Use the Tables 109.02-1 and 109.02-2 to convert units when required. If Tables 109.02-1 and 109.02-2 do not provide a required factor, then use the appropriate factor provided in the IEEE/ASTM SI 10.

TABLE 109.02-1 ENGLISH TO SI (METRIC) CONVERSION FACTORS

Symbol	When You Know	Multiply By	To Find	Symbol
Length				
mil	mils	25.4	micrometers	µm
in	inches	25.4	millimeters	mm
ft	feet	0.3048	meters	m
yd	yards	0.9144	meters	m
mi	miles	1.609347	kilometers	km
Area				
in^2	square inches	645.16	square millimeters	mm^2
ft^2	square feet	0.09290304	square meters	m^2
yd^2	square yards	0.8361274	square meters	m^2
ac	acres	0.4046873	hectares	ha
ac	acres	4046.873	square meters	m^2
mi^2	square miles	2.589998	square kilometers	km^2
Volume				
fl oz	fluid ounces	29.57353	milliliters	mL
gal	gallons	3.785412	liters	L
ft^3	cubic feet	0.02831685	cubic meters	m^3
yd^3	cubic yards	0.7645549	cubic meters	m^3
Mass				
oz	ounces	28.34952	grams	g
lb	pounds	0.4535924	kilograms	kg
T	2000 pounds	0.9071847	metric tons	t
Temperature				
°F	Fahrenheit	C = (F-32)/1.8	Celsius	°C
Illumination				
fc	foot-candles	10.76391	lux	lx
fl	foot-lamberts	3.426259	candelas per square meter	cd/m^2
Force and Pressure or Stress				
lbf·ft	pounds-force foot	1.355818	newton meter	N·m
lbf	pounds force	4.448222	newtons	N
lbf/ft^2 (psf)	pounds force per square foot	47.88026	pascals	Pa
lbf/in^2 (psi)	pounds force per square inch	0.006894757	megapascals	MPa

TABLE 109.02-2 SI (METRIC) TO ENGLISH CONVERSION FACTORS

Symbol	When You Know	Multiply By	To Find	Symbol
Length				
µm	micrometers	0.03937	mils	mil
mm	millimeters	0.03937	inches	in
m	meters	3.28084	feet	ft
m	meters	1.093613	yards	yd
km	kilometers	0.62137	miles	mi
Area				
mm^2	square millimeters	0.00155	square inches	in^2
m^2	square meters	10.76391	square feet	ft^2
m^2	square meters	1.19599	square yards	yd^2
ha	hectares	2.4710437	acres	ac
m^2	square meters	0.000247	acres	ac
km^2	square kilometers	0.3861	square miles	mi^2
Volume				
mL	milliliters	0.033814	fluid ounces	fl oz
L	liters	0.264172	gallons	gal
m^3	cubic meters	35.31466	cubic feet	ft^3
m^3	cubic meters	1.30795	cubic yard	yd^3
Mass				
g	grams	0.035274	ounces	oz
kg	kilograms	2.204622	pounds	lb
t	metric tons	1.1023114	2000 pounds	T
Temperature				
°C	Celsius	F = 1.8C + 32	Fahrenheit	°F
Illumination				
lx	lux	0.09290304	foot-candles	fc
cd/m^2	candelas per square meter	0.29186352	foot-lamberts	fl
Force and Pressure or Stress				
N·m	newton meters	0.7375621	pounds-foot force	lbf ft
N	newtons	0.22480892	pound force	lbf
Pa	pascals	0.02088543	pounds force per square foot	lbf/ft^2 (psf)
MPa	megapascals	145.03774	pounds force per square inch	lbf/in^2 (psi)

109.03 Scope of Payment. Payment of the Contract Price is full compensation for all resources necessary to complete the Contract Item and maintain the Work. Assume liability for risk, loss, damage, or expense resulting from the Work. The Contract Price and Contract Time shall only be changed by written Change Order

or as determined by the Department in writing in accordance with the contract documents.

109.04 Compensation for Altered Quantities, Eliminated Items or Termination of the Contract for Convenience of the Department. If the agreed quantities of contract items vary from the quantities in the Contract, the Department will make payment at the original Contract unit prices for the agreed quantities of Work.

A. If an item is eliminated in accordance with 104.02.E or the contract is terminated in accordance with 108.09 the Department will pay the following in addition to that provided by 104.02.D:

1. Restocking charges supported by paid invoices and an additional 5 percent markup on the compensation for overhead and profit.

2. The cost of material transferred to the Department or a local government agency in lieu of restocking or disposal. The allowed compensation is the paid invoice cost plus 15 percent markup, but no more than the unit bid price for the reference number involved.

3. Hauling costs, if not included in restocking charges, for returned material and for material delivered to the Department.

B. If the project is terminated for convenience of the Department, the Department will negotiate compensation with the Contractor for actual costs incurred as a result of the termination. The Department will pay for Extra Work as stipulated in approved Extra Work Change Orders or written authorizations subject to the limitations set forth in ORC 5525.14. Such authorizations for emergencies and to avoid Project delays are in advance of an approved Extra Work Change Order and commit the Department only to the terms of the authorizations. The Department will pay for Extra Work after the approval of the subsequent Change Order.

109.05 Changes and Extra Work.

A. General. If the Department revises the Contract under: 104.02, 105.07, 105.10, 105.13, 107.10, 107.14, 107.15, 108.09, 109.06, or 109.07, the Department will pay for changes and Extra Work with a Change Order using the sequence specified in 109.05.B through 109.05.E.

In establishing the method of payment for contract changes or extra work orders, force account procedures shall only be used when strictly necessary, such as when agreement cannot be reached with the Contractor on the price of a new work item, or when the extent of work is unknown or is of such character that a price cannot be determined to a reasonable degree of accuracy. The reason or reasons for using force account procedures shall be documented.

Unless otherwise stated in 109.05, the compensation provided in 109.05.B through 109.05.E constitutes payment in full for all changes and Extra Work completed by original Contract Price, agreed unit price, agreed lump sum price, and for work performed on a force account basis, including:

1. Administration.

2. Superintendence.

3. Project and field office overhead.

4. Home office overhead.

5. Use of tools and equipment for which no rental is allowed.

6. Profit.

7. Taxes other than sales tax.

8. Premiums on insurance including additional premiums for Commercial General Liability Insurance required by 107.12.B and any additional coverage carried by the Contractor or subcontractor, excluding pollution and railroad General Liability Insurance. The Department will pay the Contractor's pollution and railroad liability insurance premiums, if required by the contract, by a separate Change Order for the cost of the premium without any markup. When the Contractors or subcontractors basic rate for General Commercial Liability Insurance required by 107.12.B is greater than 5 percent of payroll, the Department will pay directly without markup the portion of the premium in excess of 5 percent and provide copies of paid premiums.

Sales tax will not be allowed on any item for which tax exemption was obtained.

B. Negotiated Prices. Negotiated prices for changes and Extra Work shall be comparable to prices that would have resulted from a competitive bid contract. The Engineer and Contractor will negotiate agreed unit or lump sum prices using one or more of the following methods:

1. Original Contract prices for similar work but adjusted for:

   a. increased or decreased material costs specified in 109.05.C.3.
   b. increased or decreased labor costs specified in 109.05.C.2
   c. increased or decreased equipment costs specified in 109.05.C.4

Adjustments of these prices for inflation or markup for subcontractor work is not allowed.

2. State-wide average unit price awarded for the item or items as listed in the Department's annual "Summary of Contracts Awarded." These prices may be adjusted for inflation using factors issued by the Office of Construction Administration. No markup for subcontractor work is allowed.

3. Average price awarded on three different projects of similar work and quantity. These prices may be adjusted for inflation using factors issued by the Office of Construction Administration. No markup for subcontractor work is allowed.

4. Prices computed by the Office of Estimating.

5. Cost analysis of labor, material, equipment, and markups as allowed in 109.05.C.

6. For the cost of compensable delays as defined in 108.06, prepare a cost analysis as allowed by 109.05.D.

Provide proposed pricing and cost justification for changes or Extra Work within 5 business days after the Department's request. The Department will respond within 5 business days after receipt of the Contractor's proposal. The Department and the Contractor can mutually agree to extend these 5-day time limits.

If the Department negotiates with the Contractor but does not agree on a price adjustment, the Engineer may direct the Contractor to perform all or part of the revised Work under force account.

C. Force Account.

1. General. The Engineer may direct the Contractor to perform the revised Work under force account. Submit a written proposal and estimated costs for the Work, including the planned equipment, materials, labor, and a work schedule.

The Department will pay the Contractor as specified in 109.05.C as full compensation for performing the force account Work. The Project and Contractor personnel will document the labor and equipment used on the force account work on a Daily Force Account Record. At the end of each Workday, the Project and Contractor personnel will compare and sign the Daily Force Account Record. The Department will make no force account payment before the Contractor submits an itemized statement of the costs for that work.

The Engineer will examine and, if found to be acceptable, approve all rates and costs submitted by the Contractor.

Provide the following content in itemized statements for all force account work:

a. Name, classification, date, daily hours, total hours, rate, and amount for all labor.

b. Designation, dates, daily hours, total hours of actual operation and idle time, Blue Book rate with reference or category, and amount for each unit of equipment and the applicable Blue Book hourly operating cost for each unit of equipment and invoices for all rental equipment. The designation includes the manufacturer's name or trademark, model number, and year of manufacture.

c. Quantities of materials and prices.

d. Transportation charges on materials, free on board (F.O.B.) at the job site.

e. Cost of workers' compensation insurance premiums, all applicable insurance premiums, unemployment insurance contributions, and social security tax and fees or dues required by a collective bargaining agreement. Express each of these items of cost as a percentage of payroll, except fees or dues, which should be expressed as a cost per hour.

f. Documentation showing payment for all surveying, professional, or similar specialized Work not normally a part of a Department contract.

g. If materials are taken from Contractor's stock and original receipted invoices for the materials and transportation charges do not exist, provide an affidavit and certify all of the following:

(1) The materials were taken from the Contractor's stock.

(2) The quantity shown was actually used for the force account work.

(3) The price and transportation costs represent the actual cost to the Contractor.

h. Documentation showing payment to trucking firms and owner-operators. Submit documentation showing owner-operations status. When the trucking is subject to prevailing wage, submit payroll and equipment usage records according to 109.05.C.1.a, 109.05.C.1.b, and 109.05.C.1.e.

i. Provide "receipted invoices" for all costs substantiated by an invoice.

If only part of the expenditure represented by an invoice is applicable to force account work, or if the invoice represents expenditure for more than one item of work, clearly indicate the actual amount of expenditure applicable to each item of work.

2. Labor. The Department will pay the wages and fringe benefits currently in effect for each hour the Work is performed by all labor employed in the Work and all foremen in direct charge of the specific operation. The Department will pay an additional 38 percent markup on these wages and benefits. "Fringe benefits" are the actual costs paid to, or on behalf of, workmen by reason of health and welfare benefits, pension fund benefits, or other benefits, when such amounts are required by prevailing wage laws or by a collective bargaining agreement or other employment contracts generally applicable to the classes of labor employed on the Project.

The Department will pay the actual itemized cost, without markup, of the following payroll taxes and legally required insurances:

a. Social Security Tax.

b. Medicare Tax.

c. Ohio Workers' Compensation Premiums.

d. State and Federal Unemployment Insurance.

e. Longshore and Harborworkers' Compensation Insurance for work from a barge or ship, or unloading material from a barge or ship.

Provide itemized statements in addition to the documentation requirements for all labor including the name, classification, date, daily hours, total hours, rate, and amount. If any person is paid more than the one rate, a separate listing shall be made for that person for each rate paid. Provide itemized statements for Ohio Workers' Compensation insurance premiums, all applicable insurance premiums, State and Federal Unemployment Insurance contributions, and Social Security Tax and fees or dues required by a collective bargaining agreement. Express each of these items of cost as a percentage of payroll, except fees or dues, which shall be expressed as a cost per hour.

Instead of itemizing the cost of Social Security Tax, Ohio Workers' Compensation, and State and Federal Unemployment Insurance, the Contractor may

elect to receive as compensation for these payroll taxes and premiums, an amount equal to 22 percent of the paid wages. If the Contractor pays fringes directly to the worker in lieu of paying into a fringe benefit program, then the Department will treat these fringe payments as paid wages when calculating the allowed 22 percent compensation.

The Department will pay, without markup, the actual itemized cost of fees and dues paid to labor unions or to business associations when they are based on payroll hours and required by a collective bargaining agreement.

The Department will not pay for wages or benefits for personnel connected with the Contractor's forces above the classification of foreman that have only general supervisory responsibility for the force account work.

If the foreman or timekeeper is employed partly on force account work and partly on other work, the Contractor shall prorate the number of hours between the force and non-force account work according to the number of people on each task as shown on payrolls.

The Department will pay the prevailing wage and fringe rates that apply to the Project for the classifications required for Extra Work. The Contractor must provide payroll records for pay rates higher than the prevailing wages and establish that the higher than prevailing rates are paid for original Contract Work. The Department will pay for foremen and time keepers not covered by prevailing wages not more than the salaried rate they receive when engaged in original Contract Work.

The Department will pay actual costs for subsistence and travel allowances when such payments are required by the collective bargaining agreement or other employment contracts applicable to the classes of labor employed on the Project. The Department will not pay a percent markup on these costs.

3. Materials. The Department will pay the Contractor's actual invoice costs, including applicable taxes and actual freight charges, for Engineer approved materials the Contractor uses in force account Work. The Department will pay an additional 15 percent markup on these costs.

Freight or hauling costs charged to the Contractor and not included in unit prices shall be itemized and supported by invoices. The cost of owned or rented equipment used to haul materials to the project is not part of the materials cost. Such equipment, when used for hauling materials, shall be listed under cost of equipment.

Provide itemized statements in addition to the documentation requirements for all equipment including the quantity and price of each material and transportation charges free on board (F.O.B.) at the job site. Attach invoices to support the quantities of materials used, unit prices paid and transportation charges. If the Contractor uses materials from the Contractor's stock and original receipted invoices for the materials and transportation charges do not exist, the Department and the Contractor will agree on a price that represents the actual cost to the Contractor. Provide an affidavit and certify all of the following:

a. The materials were taken from the Contractor's stock.

b. The quantity shown was actually used for the force account work.

c. The price and transportation costs represent the actual cost to the Contractor.

Do not incorporate materials into the Work without a price agreement.

4. Equipment.

a. General. The Department will pay the Contractor's costs for equipment the Engineer deems necessary to perform the force account work for the time directed by the Engineer or until the Contractor completes the force account Work, whichever happens first. The Department will pay the Contractor the established rates for equipment only during the hours that it is operated, except as otherwise allowed elsewhere in these Specifications. The Department will pay for non-operating hours at the idle equipment rate as specified in 109.05.C.4.c. Report equipment hours to the nearest 1/2 hour. The established equipment rates in these Specifications include compensation for overhead and profit except as otherwise specified.

The Department will pay for use of Contractor-owned equipment the Engineer approves for force account Work at established rates. The Department will pay the rates, as modified in 109.05.C.4.b, given in the Equipment Watch Cost Recovery (formerly Rental Rate Blue Book), by EquipmentWatch, a division of Penton Business Media, Inc.

Provide, and the Engineer will confirm, the manufacturer's ratings and manufacturer-approved modifications required to classify equipment for rental rate determination. For equipment with no direct power unit, use a unit of at least the minimum recommended manufacturer's rating.

The Department will not pay rental for small tools or equipment that show a daily rate less than $5.00 or for unlisted equipment that has a value of less than $400.

Tool trucks will be allowed for compensation if they are used at the force account site. Only the tools used from the tool truck will be allowed for compensation. Tools in the tool truck that are not used in the force account work will not be compensated. A tool trailer that remains at the Contractor's office or yard will not be allowed on the force account work. Tool trailers that are taken to the force account site will be allowed for compensation along with the tools used on the force account work that were taken from the trailer.

Treat traffic control devices used in Maintaining Traffic and owned by the Contractor as owned equipment. Allowed rates for common traffic control devices and concrete barrier that are not listed in the Blue Book will be as determined by the Department.

Use Engineer approved equipment in good working condition and providing normal output or production. The Engineer may reject equipment not in good working condition or not properly sized for efficient performance of the Work.

For each piece of equipment used, whether owned or rented, provide the Engineer with the following information:

(1) Manufacturer's name or trademark.

(2) Equipment type.
(3) Year of manufacture.
(4) Model number.
(5) Type of fuel used.
(6) Horsepower rating.
(7) Attachments required, together with their size or capacity.
(8) All further information necessary to determine the proper rate.
(9) Dates, daily hours, total hours of actual operation and idle time,
(10) Blue Book rate with reference or category,
(11) Amount
(12) Applicable Blue Book hourly operating cost
(13) Invoices for all rental equipment.

b. Hourly Owned Equipment Rates. The base rate for the machine and attachments represent the major cost of equipment ownership, such as depreciation, interest, taxes, insurance, storage, and major repairs. The hourly operating rate represents the major costs of equipment operation, such as fuel and oil lubrication, field repairs, tires, expendable parts, and supplies.

For all equipment used on force account work, determine, and have the Department confirm, the hourly owned equipment rates as follows:

$$HOER = [RAF \times ARA \times (R / 176)] + HOC$$

Where:

HOER = hourly owned equipment rate
RAF = regional adjustment factor shown in the Blue Book
ARA = age rate adjustment factor shown in the Blue Book
R = current Blue Book monthly rate
HOC = estimated hourly operating cost shown in the Blue Book

However, compensation for equipment normally used on a 24 hours per day basis will not exceed the monthly rate plus adjustments and operating costs.

The rate adjustment factor assigned to any attachment will be the yearly factor as determined for the base equipment.

When multiple attachments are included with the rental equipment, only the attachment having the highest rental rate will be eligible for payment, provided that the attachment has been approved by the Engineer as being necessary to the force account Work.

When a piece of owned equipment is not listed in the Blue Book, use the rate for similar equipment found in the Blue Book or use 6 percent of the purchase price as the monthly rate (R) and add the hourly operating rate found in the Blue Book for similar equipment of the same horsepower.

For equipment brought to the Project exclusively for force account work and on the Project for less than a month, multiply the monthly rate (*R*) by the factor listed below:

TABLE 109.05-1

Working Hours	Factor
Less than or equal to 8.0	2.00
8.1 to 175.9	2.048 - (hours/168)
176 or greater	1.00

The term "WORKING HOURS," as used in Table 109.05-1, includes only those hours the equipment is actually in operation performing force account work; apply the factor, as determined above, to these actual working hours only. Calculate compensation for any idle time according to 109.05.C.4.c without application of the factor.

The Department will pay as working equipment for the entire Workday equipment used intermittently during the Workday. The following criteria qualify for intermittently used equipment:

(1) Equipment dedicated to the force account exclusively all day and not used on bid work.

(2) Equipment works before and after the intermittent idle period and its total working time during the Workday is at least 2 hours.

Equipment that is captive to the force account work (i.e. it must remain at the force account site), but does not qualify for intermittently used owned equipment, is paid as idle equipment according to C&MS Section 109.05.C.4.c. for the time it is not working.

c. Hourly Idle Equipment Rate. For equipment that is in operational condition, on site, and necessary for force account Work, but is idle, the Department will pay an hourly idle equipment rate. The procedure to determine the hourly idle equipment rate for Contractor owned equipment is as follows:

$$HIER = RAF \times ARA \times (R / 176) \times (1/2)$$

Where:

HIER = Hourly idle equipment rate.
RAF = Regional adjustment factor shown in the Blue Book.
ARA = Age rate adjustment factor shown in the Blue Book.
R = Current Blue Book monthly rate.

If rented equipment necessary for force account work is idle, the Department will pay the Contractor for the actual invoiced rates prorated for the duration of the idle period. The actual invoiced rates must be reasonably in line with the Blue Book rates and approved by the Engineer. The Department will pay a 15 percent markup for overhead and profit for the actual invoiced rates during the idle period.

The Department will not pay idle owned equipment costs for more than 8 hours in a 24-hour day or 40 hours in a week.

The Department will not pay for inoperable equipment.

The Engineer may order specific equipment to the site up to 5 days before its planned usage. If this equipment is not used for other work, the Department will pay for it as idle equipment until used.

The Department will pay for the cost of idle owned or rented equipment when the Work was suspended for the convenience of the State. The Department will not pay the cost of idle equipment when the Work was suspended by the Contractor for the Contractor's own reasons.

The Department will only pay for the number of Calendar Days during the existence of the suspension. The Department will not compensate the Contractor for days that the Engineer determined were lost to weather.

The Department will only pay for equipment physically located at the Project site that was received to prosecute the scheduled work during the delay.

Compensation for idle equipment will stop at the completion of the force account Work or at the end of the suspension of Work.

d. Rented Equipment. The Department will pay a 15 percent markup for overhead and profit for all rented equipment, its corresponding Blue Book hourly operating costs, and State and Local sales taxes.

(1) Equipment Rented Solely for Force Account Work. If the Contractor rents or leases equipment from a third party exclusively for force account Work, the Department will pay the actual invoiced amount. The actual invoiced rates must be reasonably in line with the Blue Book and approved by the Engineer. The Department will pay a 15 percent markup for overhead and profit for all rented equipment paid for by the actual invoices. Add the Blue Book hourly operating cost to the marked up actual invoiced rates.

(2) Equipment Rented for Original Contract Work, but Used for Force Account Work. If the Contractor uses rented equipment currently on the Project for original Contract Work to perform force account Work, then determine the hourly outside-rented equipment rate as follows:

$$HRER = (HRI \times 115\%) + HOC$$

Where:

HRER = hourly rented equipment rate
HRI = hourly rental invoice costs prorated for the actual number of hours that rented equipment is operated solely on force account work. Use a monthly invoice rate divided by 176, a weekly invoice rate divided by 40, or a daily invoice rate divided by 8.
HOC = hourly operating cost shown in the Blue Book

The Department will not compensate for rental rates that exceed the Blue Book rates unless approved in advance of the Work by the Engineer.

e. Moving of Equipment. The Department will also pay for the time required to move needed equipment to the location of the force account work and to return it to its original location. The Department will pay for loading and

transportation costs instead of moving time if equipment is moved by means other than its own power. Moving time back to the original location or loading and transportation costs will not be allowed if the equipment is used at the site of the force account work on contract items or related work.

The Department will consider the actual cost of transferring the equipment to the Project and returning it to the original location as an additional expense and pay for it as specified, for equipment moved on the Project exclusively for force account work.

The Engineer will confirm the original location of the equipment before the Contractor moves and uses it for force account work.

If the equipment is transported by a common carrier, the allowance is the invoiced amount paid for the freight plus 15 percent. However, if the Contractor's forces transport the equipment, the allowable compensation will be Blue Book rate of the hauling unit and hourly Blue Book operating cost plus the driver's wages and the cost of loading and unloading the equipment calculated according to 109.05.C.2.

5. Foreman's Transportation. The Department will pay the Blue Book rate for every hour the foreman's truck is on the force account site or moving to or from the site. This rate includes equipment cost, fuel and lubricants, overhead, profit, and mobile phone or two-way radios.

6. Subcontract Work. For Work performed by an approved subcontractor, the Department will pay an amount to cover administrative costs of 8% on the first $10,000 of work and 5% for work in excess of $10,000 as provided in 109.05.C.2 through 109.05.C.5. No additional mark-up is allowed for work of a sub-subcontractor or trucking services employed by a subcontractor.

7. Final Adjustment to Premium for Contract Bonds. The final bond premium amount for the payment and performance bonds will be computed based on the actual final contract value. For the purpose of computing a bond premium adjustment the actual final contract value is defined as the whole sum of money, excluding any bond premium adjustment, which is passed from the Department to the Contractor as a result of the completion of the Work. If the actual final contract value is different from the original contract value, the premium shall be adjusted accordingly; either by refund of part of the original bond premium by the Contractor if the original contract value is larger than the actual final contract value; or by payment of additional bond premium by the Department if the original contract value is smaller than the actual final contract value. Additional payment by the Department or refund by the Contractor will be based on the difference between the invoiced bond premium for the original contract value and the invoiced bond premium for the actual final contract value without any markup. A final bond premium adjustment will not be made when the actual final contract value differs from the original contract value by less than $ 40,000.00.

8. Trucking.

a. Trucking firms and owner operators not subject to prevailing wage will be paid at the invoiced cost plus 8% on the first $10,000 of trucking and 5% for trucking in excess of $10,000 to cover administrative costs.

b. Trucking that is subject to the prevailing wage law will be compensated according to 109.05.C.1, 109.05.C.2, 109.05.C.4, 109.05.C.6, and 109.05.C.10.

Provide documentation showing payment to trucking firms and owner-operators and owner-operations status. When the trucking is subject to prevailing wage, submit payroll and equipment usage records according to 109.05.C.2 and 109.05.C.4.

9. Professional and Specialized Work. The following work, when performed by a firm hired by the Contractor, is paid at the reasonable and fair market invoiced cost plus 8% on the first $10,000 of work and 5% for work in excess of $10,000.

a. Surveying.

b. Engineering design.

c. Specialized work that is not normally part of a Department Contract and is not normally subject to prevailing wage.

d. Installation, periodic maintenance, and removal of traffic control devices under Item 614 performed by a traffic control service or rental company, provided the workers are not on the Project full-time. Maintenance of Traffic services performed by LEO.

e. Other professional or specialized work not contemplated at the time of Bid.

Provide documentation showing payment for professional and specialized Work.

10. Payment for Force Account Work. Submit an analysis of estimated cost prepared in accordance with 109.05C for work that will be performed on a force account basis. Attach an original affidavit to the analysis stating:

"Labor rates shown are the actual rates paid for labor, unit prices for materials and rates for owned and rented equipment have been estimated on the basis they are not in excess of those charged in the area in which the work will be performed."

The Engineer will process an Estimated Cost of Force Account (ECFA) if the amount of the force account work is likely to be greater than $100,000 and is expected to take more than two weeks to complete. The Engineer will process an Actual Cost of Force Account (ACFA) to make any necessary adjustment between the ECFA and the final itemized costs for the force account work.

For force account work estimated to be less than $100,000 and anticipated to require less than two weeks to perform, the Engineer will process an Actual Cost of Force Account (ACFA) at the conclusion of the work.

Submit biweekly itemized statement of costs prepared from the Daily Force Account Records to the Engineer as the work is being performed. The Engineer will process estimates as the force account work is performed. Payment will only be made upon receipt of the Contractor's itemized statement of costs.

Upon conclusion of the work performed by an ECFA or work performed by an ACFA submit an itemized statement of the actual costs prepared from the Daily Force Account Record and utilizing the Department's electronic template titled "Electronic Force Account." Submit a compact disk (CD), labeled with the Contractor's name and the project number, and a hard copy of the "Electronic Force Account." The "Electronic Force Account" template can be downloaded from the following website:

www.dot.state.oh.us/divisions/constructionmgt/admin/pages/default.aspx

The Engineer may approve an alternative electronic template provided all calculations and printouts are equivalent to those generated by the "Electronic Force Account" template.

Attach an original affidavit to the hard copy stating:

"The name, classification, total hours worked and rates paid each person listed on the Summary of Actual Cost are substantiated by actual records of persons employed on the force account work. All unit prices for materials and rates for owned and rented equipment listed on the Summary of Actual Costs are substantiated by actual records of materials and equipment actually used in performance of the force account work and the price of any owned equipment not previously agreed upon does not exceed prices charged for similar equipment in the area in which the work was performed."

Daily Force Account Records signed by both the Department and Contractor will govern over other Department and Contractor records subject to the following:

a. When the Contractor is subject to a Union Contract that requires a minimum number of paid hours, the compensation will be for the verified contract minimum hours.

b. Material quantity disagreements will be resolved by field measurements of the installed quantities or the Engineer's estimate of the amount of temporary or un-measurable material used. The Engineer may also review and consider the Contractor's material invoices and material certifications to make the final determination.

In the event the Contractor declines to sign the Daily Force Account Record, the Department's records shall govern. Any resulting dispute must be pursued in accordance with 108.02.G.

D. Delay Costs.

1. General. If the Department agrees that it has caused a delay, the Department will pay for the costs specified in 109.05.D as allowed by 108.06.D, unless these costs have been previously paid as listed in 109.05.B or 109.05.C. Such payment constitutes full compensation for any and all delay costs

The Department will make no payment for delays occurring during the period from December 1 to April 30 unless the Contractor's approved progress schedule depicts critical Work occurring throughout this period.

The Department will not pay for delay costs until the Contractor submits an itemized statement of those costs. Provide the content specified in 109.05.C.1, for the applicable items in this statement and as follows:

a. Proof of cost of Superintendent, or other project staff salaries, wages, and payroll taxes and insurance.

b. Proof of cost of office rent, utilities, land rent, and office supplies.

c. Proof of escalated cost for labor and material.

d. Proof of material storage costs.

2. Allowable Delay Costs

a. Extended Labor. Compute labor costs during delays as specified in 109.05.C.2 for all non-salaried personnel remaining on the Project as required under collective bargaining agreements or for other Engineer-approved reasons.

b. Escalated Labor. To receive payment for escalated labor costs, demonstrate that the Department-caused delay forced the Work to be performed during a period when labor costs were higher than planned at the time of Bid. Provide adequate support documentation for the costs, allowances, and benefits specified in 109.05.C.2. The Department will pay wages and fringes with a 20 percent mark-up to cover administrative costs.

c. Idle Equipment or Equipment Demobilization. The Department will pay the Contractor according to 109.05.C.4.c for idle equipment, other than small tools, that must remain on the Project during the delays. The Department will pay the Contractor's transportation costs to remove and return equipment not required on the Project during the delays. No other equipment costs are recoverable as a result of delay.

d. Material Escalation or Material Storage. The Department will pay the Contractor for increased material costs or material storage costs due to the delay. Obtain the Engineer's approval before storing materials due to a delay. Payment will be based upon the accepted quantity of work performed during the period for which escalated costs have been approved. The Department will pay increased material costs with an 8 percent mark-up to cover administrative costs and any material waste inherent to the Work.

e. Field Overhead. The Department will pay any Contractor or subcontractor for field overhead costs which include the cost of supervision, field office and office supplies, and utilities for which payment is not provided for in 109.05.D.2.f, during a delay period provided all of the following criteria are met:

(1) The Contractor or subcontractor has incurred an excusable, compensable delay that delays the Work at least 10 Calendar Days beyond the original Completion Date. These days are cumulative throughout the project.

(2) The delay for which payment of field overhead is sought is only due to delays defined in 108.06.D.2, 108.06.D.3, 108.06.D.5 or for delays due to revised Work as specified in 104.02.B or 104.02.F.

The Department will pay the salary and fringes plus a 5 percent markup for field personnel identified in Table 109.05-4.

TABLE 109.05-4

Original Contract Amount	Field Personnel
Up to $5,000,000	One Superintendent
$5,000,001 to $50,000,000	One Superintendent, One Assistant Superintendent or One Engineer, One Clerk
Over $50,000,000	One Superintendent, One Assistant Superintendent, One Engineer, One Clerk

Superintendent's transportation is compensable at the same rate allowed for foreman's transportation in Section 109.05.C.5, which includes the cost of mobile communication devices. The allowed hours are when the superintendent is at the project site.

Superintendent's subsistence, provided this is the company's terms of compensation to such employees, as documented by the Contractor's written company policy or contracts with their employees.

The Contractor's or subcontractor's field office costs include field office trailers, tool trailers, office equipment rental, temporary toilets, and other incidental facilities and supplies. Compute these costs on a Calendar Day basis. Owned trailers are paid at the Blue Book rate. Rented trailers are paid at the invoiced cost plus a 15 percent markup. Rented office space, toilets, and office equipment are allowed a 5 percent markup. Purchased office supplies are allowed a 5 percent markup.

Office utilities include, but are not limited to, telephone, electric, water, and natural gas. Compute these costs on a Calendar Day basis and allow a 5 percent markup.

f. Home Office Overhead. The Department will pay the Contractor for home office overhead, unabsorbed home office overhead, extended home office overhead, and all other overhead costs for which payment is not provided for in 109.05.D.2.e, including overhead costs that would otherwise be calculated using the Eichleay formula or some other apportionment formula, provided all of the following criteria are met:

(1) The Contractor has incurred an excusable, compensable delay that delays the Work at least 10 Calendar Days beyond the original Completion Date. These days are cumulative throughout the project.

(2) The delay for which payment of home office overhead is sought is only due to delays defined in 108.06.D.2, 108.06.D.3 and 108.06.D.5.

Any subcontractor that has approved C-92's for subcontracted work totaling $4,000,000 or more is eligible for reimbursement of home office

overhead provided the criteria set forth in 109.05.D.2.f.(1) and 109.05.D.2.f.(2) are met.

Payment will be made for every eligible day beyond the original contract completion date at the rate determined by 109.05.D.2.f.i. Payment for eligible days occurring during an unanticipated construction period will be calculated in accordance with 109.05.D.2.f.ii. Payment for eligible days occurring during an unanticipated winter period will be calculated in accordance with 109.05.D.2.f.iii.

(i) Home Office Overhead Daily Rate

Calculate the home office overhead daily rate using the following formula:

$$\text{Daily HOOP} = (A \times C)/B$$

Where:

A = original contract amount
B = contract duration in Calendar Days
C = value from Table 109.05-5

TABLE 109.05-5

Original Contract Amount	C
Up to $5,000,000	0.08
$5,000,001 to $25,000,000	0.06
Over $25,000,000	0.05

Daily HOOP = home office overhead daily rate

Contract duration term, B, includes every Calendar Day from the execution of the Contract, unless otherwise specified by the Director, to the original Contract Completion Date.

When the Contractor requests home office overhead compensation for a subcontractor, use the above formula to calculate the subcontractor's Daily HOOP; however, in the subcontractor calculation, A is equal to the subcontractor's portion of the original contract amount as determined by the sum of all approved C-92's issued for the subcontracted work.

(ii) Home Office Overhead Payment for an Unanticipated Construction Period

Calculate the home office overhead payment for an unanticipated construction period occurring between May 1 and November 30 using the following formula:

$$\text{CP HOOP} = \text{Daily HOOP} \times D$$

Where:

D = sum of all excusable, compensable delays in Calendar Days minus the sum of all delays due to 108.06.D.1 and 108.06.D.4 in Calendar Days
Daily HOOP = daily home office overhead rate

CP HOOP = home office overhead payment for an unanticipated construction period occurring between May 1 and November 30

The excusable, compensable delay term, D, is the additional, unanticipated extended period for work performed between May 1 and November 30 in Calendar Days.

(iii) Home Office Overhead Payment for an Unanticipated Winter Period

Calculate the payment for home office overhead for an unanticipated winter period occurring between December 1 and April 30 using the following formula:

$$WP\ HOOP = Daily\ HOOP \times F \times D/E$$

Where:

D = sum of all excusable, compensable delays in Calendar Days minus the sum of all delays due to 108.06.D.1 and 108.06.D.4 in Calendar Days
E = sum of all excusable, compensable delays in Calendar Days plus the sum of all excusable, non-compensable delays in Calendar Days
F = 151 for a non-leap year or 152 for a leap year
Daily HOOP = daily home office overhead rate
WP HOOP = home office overhead payment for an unanticipated winter period occurring between December 1 and April 30

Payment for Home Office Overhead for an unanticipated winter period will not be made when the value of the remaining work is below the lesser of $500,000.00 or 10 percent of the estimated final contract value.

(iv) Total Home Office Overhead Payment

Calculate the total home office overhead payment using the following formula:

$$Total\ HOOP = CP\ HOOP + WP\ HOOP$$

Where:

CP HOOP = home office overhead payment for an unanticipated construction period occurring between May 1 and November 30
WP HOOP = home office overhead payment for an unanticipated winter period occurring between December 1 and April 30
Total HOOP = total home office overhead payment

g. Subsistence and Travel Allowance. The Department will pay costs for subsistence and travel allowances for labor that must remain on the Project during the delays, when such payments are required by the collective bargaining agreement or other employment contracts applicable to the classes of labor employed on the project. Overnight lodging will be reimbursed if the person is at a location greater than forty-five miles from their residence up to a maximum of $106

per day. Meals and incidental expenses will reimbursed up to a maximum of $56 per day. The Department will not pay a percent markup on these costs.

E. Changes in Materials. Changes in material specifications that result in increased cost to the Contractor are compensated by lump sum adjustment to the reference number. The allowed compensation is equal to the invoice supported material cost increase plus 15 percent markup for profit and overhead.

Material cost savings resulting from a specification change shall be credited to the project by a lump sum adjustment to the reference number plus a 15 percent markup if the originally specified material has not been ordered.

If the original material was ordered before the Contractor was informed of the change, the savings markup allowed is 2.5 percent in order to exclude profit on the original bid price and pay only for incurred overhead.

109.06 Directed Acceleration. The Engineer may order the Contractor to accelerate the Work to avoid delay costs or to complete the Project early. The Director and the Contractor will negotiate acceleration costs.

109.07 Inefficiency. The Department will compensate the Contractor for inefficiency or loss of productivity resulting from 104.02 Revisions to the Contract Documents. Use the Measured Mile analysis comparing the productivity of work impacted by a change to the productivity of similar work performed under un-impacted conditions to prove and quantify the inefficiency.

Provide notice as per 108.02.F when inefficiency or loss of production is experienced resulting from 104.02 Revisions to the Contract Documents.

Use the following calculation for the Measured Mile analysis:

Additional Crew Hours = (Unit Productivity Unimpacted Period – Unit Productivity Impacted Period) / Unit Productivity Unimpacted Period x (Number of Units During Impacted Period/Unit Productivity Impacted Period).

109.08 Unrecoverable Costs. The Contractor is not entitled to additional compensation for costs not specifically allowed or provided for in 109.05 including, but not limited to, the following:

A. Loss of anticipated profit.

B. Consequential damages, including loss of bonding capacity, loss of bidding opportunities, insolvency, and the effects of force account work on other projects, or business interruption.

C. Indirect costs.

D. Attorney's fees, claim preparation expenses, and the costs of litigation.

109.09 Estimates. If satisfactory progress is being made, the Contractor will receive monthly payments equaling the Work and materials in place. The monthly payment is approximate, and all partial estimates and payments are subject to correction in the Final Estimate and payment. Payment for Work and materials shall not, in any way, prevent later rejection when defective Work or material is discovered, or constitute acceptance under 109.11 or 109.12. Any pay item deficient in material approval can be withheld for payment on an estimate.

Except for the final estimate, the Department will not pay an estimate until the Contractor certifies to the Engineer that the work for which payment is being made was performed in accordance with the contract. Certification will be made on forms provided by the Department.

The Department may pay estimates twice each month if the Engineer concludes the amount of work performed is sufficient.

No estimate or payment shall be construed as acceptance of defective Work or improper materials.

The Department will not pay the adjusted final estimate until the Contractor remedies all defective Work and accepted Work damaged by the Contractor's operations.

Interest will be paid in accordance with ORC 126.30 when warranted.

109.10 Payment for Delivered Materials. The Department will pay, up to 75 percent of the applicable contract item, for the invoiced cost of the delivered and approved materials before they are incorporated in the Work, if the approved materials are delivered, accepted, and properly stored on the project or stored in acceptable storage places in the vicinity of the Project.

The Department will pay for the cost of approved materials before they are incorporated in the Work when asked by the Contractor, if the Engineer determines that it is not practical to deliver the material to the Project site. This provision applies only to bulky materials that are durable in nature and represent a significant portion of the project cost, such as aggregates, steel, and precast concrete. The Department will pay for un-fabricated structural steel if the following requirements are met:

A. The Contractor has provided both the Engineer and the Office of Materials Management an itemized invoice from the steel mill for the steel for which reimbursement is requested

B. Project structural Steel design plans are complete with no forthcoming revisions. For design build projects, Contractor accepted show drawings per 501.04, will need to be provided.

C Contractor accepted certified test data for all steel in question along with mill shipping notices have been received by the Office of Materials Management per 501.06.

D. The steel is properly stored to allow inspection by the Office of Materials Management. It shall also be properly set apart from other material and identified as belonging to ODOT.

E. The Contractor will provide the Engineer a written statement that under 106, the Contractor is responsible for the steel that has been paid for until the actual steel is erected and accepted in the field.

F. Payment shall only be authorized after all the aforementioned documentation has been received by the Office of Materials Management and the steel has been inspected by the Office of Materials Management to verify that all steel listed in the itemized invoice has been received by the fabricator and properly stored. The

amount to be paid shall be equivalent to the itemized invoice from the steel mill, but shall not exceed 50% of the bid price for the structural steel.

The Department will not pay delivered materials on small warehouse items or for plant materials.

109.11 Partial Acceptance. Upon completion of a portion of the Work, the Contractor may request acceptance of a completed portion of the Work.

A. An inspection may be performed on a completed portion of the project roadway section provided:

1. All safety items are in place including permanent pavement markings.

2. Traffic is in its final pattern.

3. A completed portion of the project constitutes a completed geographic section of the project or a direction of traffic on a divided highway.

4. Is in accordance with other contract provisions.

B. An inspection may be performed on a completed bridge provided:

1. All work on the bridge and approaches are complete, including all safety items and permanent pavement markings.

2. The Contractor will not return to the bridge for any work except as allowed in 4.

3. Traffic is in its final pattern.

4. Painting of structural steel is either completed or scheduled to be performed.

5. Is in accordance with other contract provisions.

The Final Inspector will grant written partial acceptance for that portion of the Work or reject the Contractor's request. Such written partial acceptance will designate what portion of the Work is accepted, the date of acceptance, and the warranty provisions started by the partial acceptance.

Partial acceptance will relieve the Contractor of maintenance responsibility for the designated portion of the Work. This does not relieve the Contractor of responsibility to correct defective Work or repair damage caused by the Contractor or waive any other remedy to which the Department is entitled at law or in equity.

109.12 Final Acceptance.

A. Final Inspection. The Department will perform a Final Inspection for the sole purpose of relieving the Contractor of maintenance responsibility for the Work.

The Final Inspection shall be a limited visual review of the Work and shall only serve as the Department's verification that the Work appears substantially complete. Final Inspection does not waive any available rights or remedies of the Department, nor divest the Contractor of any responsibility for compliance with the contract or liability for damages.

Notify the Engineer when the Project is complete and all of the Engineer's punch list items are complete. If the Engineer agrees the Project is complete, then within 15 business days the District Final Inspector will inspect the Work and categorize it as one of the following:

1. Unacceptable or not complete.

2. Substantially complete with punch list items found by the Final Inspector.

3. Substantially complete.

If the Final Inspector finds the Work substantially complete or substantially complete with punch list items, then the Contractor's maintenance responsibilities end on the day of the Final Inspection, except for any maintenance related to unfinished punch list items. This does not relieve the Contractor of responsibility to correct defective Work or repair damage caused by the Contractor or waive any other remedy to which the Department is entitled at law or in equity. The Final Inspector will issue a Final Inspection Report that will document the findings of the inspection and start any warranty period.

B. Punch List. The Final Inspector will issue to the Contractor a written punch list of work required as a condition of acceptance. For project involving multiple public agencies, the Final Inspector will receive and compile punch lists from all agencies that have authority to provide one prior to issuing the Department's punch list. The Final Inspector's punch list will stipulate a reasonable time to complete the required Work. Failure of the Contractor to complete the punch list items by the stipulated time will result in the assessment of fifty percent of the Liquidated Damages according to 108.07 for each Calendar Day for every day beyond the stipulated time the punch list work remains incomplete and beyond the revised Completion Date.

C. Finalization. The Contractor shall accept the final quantities as determined by the Engineer or provide a written notice indicating the reason for disagreement within 30 Calendar Days of receiving the Engineer's list of final quantities. The prescribed 30 Calendar Day period can be modified by mutual agreement of the Contractor and the District Construction Engineer. If no notice of disagreement is received, then the final payment will be based on the Engineer's list of final quantities.

Supply all documents necessary for Project finalization within 60 Calendar Days from the date that the Work is physically complete. These documents include:

1. Delinquent material certifications.

2. Delinquent certified payrolls or required revised payrolls.

3. Wage affidavit required by ORC Chapter 4115 on projects without any Federal funding.

4. Delinquent force account records.

5. If applicable, DBE affidavits.

6. Any other document required to complete finalization of the project.

Failure to submit these acceptably completed documents will result in an administrative fee of $100 per Calendar Day for every day that any of the required documents remain delinquent, starting 30 Calendar Days after receipt of written notification from the Engineer of a document deficiency.

D. Final Payment. Final payment is based on:

1. The agreed final quantities or as determined by the Engineer if agreement is not possible, no compensation for unauthorized work is allowed.

2. Finding of substantial completion by the Final Inspector.

3. Receipt of acceptable finalization documents.

4. Contractor certification that the Work was performed in accordance with the contract.

E. Completion of Contract and Continuation of Contractor's Responsibility. The Contract is complete, except for items covered by the required bonds, when the Contractor receives final payment. The DCA will issue a letter confirming completion of the contract, noting any exception as provided in Items 659 and 661 and any warranty. The date the final payment is approved by the District constitutes acceptance for the purpose of ORC 5525.16. Neither completion of the Contract nor substantial completion relieves the Contractor of any responsibilities to properly perform or correct the Work or to repair damage or waives any remedies to which the Department is entitled at law or in equity.

200 EARTHWORK

ITEM 201 CLEARING AND GRUBBING

201.01 Description. This work consists of clearing, grubbing, scalping, removing trees and stumps, and removing all vegetation and construction debris from the limits shown on the plans, except such objects that are to remain or are to be removed according to other items of work.

Use removed or excavated materials in the work when the material conforms to the specifications; if not then recycle, burn, or dispose of the material according to 105.16 and 105.17.

201.02 General

A. Remove or save all trees, shrubs, and plants as designated on the plans. Preserve all vegetation and objects not designated for removal. Paint cut or scarred surfaces of trees or shrubs selected for retention according to 666.04.

B. In order to retard and prevent the spread of destructive insects, limit the movement of regulated articles according to Ohio Administrative Code 901:5 (http://codes.ohio.gov/oac/901:5). Observe requirements for handling and transporting of regulated articles in quarantined areas as defined by the Ohio Department of Agriculture (www.agri.ohio.gov).

Follow all other federal and state destructive insect quarantines.

C. Restrictions on when the Contractor may perform the clearing and grubbing work are located in other parts of the Contract Documents.

201.03 Clearing and Grubbing. Clear and grub all trees and stumps marked for removal and all surface objects, brush, roots, and other protruding obstructions not designated to remain, except for special treatments listed below:

A. In locations to be seeded, remove stumps at least 6 inches below ground surface.

B. In unseeded areas to be rounded at the top of backslopes, cut the stumps flush with or below the surface of the final slope line.

C. The Contractor may leave undisturbed stumps and roots, and nonperishable solid objects 6 inches above the existing ground surface in the plan embankment construction locations when both of the following conditions are true:

1. The embankment height is greater than 9 feet as measured vertically from the existing ground surface to the proposed ground surface, and

2. The slope of the existing ground is 8:1 or flatter.

D. In locations outside of the construction limits of the cut and embankment areas not to be seeded, the Contractor may leave sound stumps 24 inches above the existing ground surface.

Except in areas to be excavated, backfill stump holes and other holes created by removing obstructions with Item 203 embankment material. Place and compact according to Item 203.

Remove low hanging, unsound, or unsightly branches on trees or shrubs designated to remain. Trim branches of trees extending over the roadbed to provide a clear height of 20 feet above the roadbed surface.

Dispose of debris contaminated with garbage, solid waste, or hazardous waste or material according to other contract items.

201.04 Scalping. Scalping includes removing surface material such as roots, sod, grass, residue of agricultural crops, sawdust, and decayed vegetable matter. The depth of scalping does not include topsoil or other material below the scalping operation. The Engineer will not require areas to be scalped in the plan embankment construction locations when both of the following conditions are true:

A. The embankment height is greater than 9 feet as measured vertically from the existing ground surface to the proposed ground surface, and

B. The slope of the existing ground is 8:1 or flatter.

Scalp all other areas where excavation or embankment is required.

201.05 Method of Measurement. The Department will measure by one of the following methods:

If Clearing and Grubbing is specified in the Contract, the Department will not measure the area cleared and grubbed.

If Item 201 Tree Removed or Item 201 Stump Removed is specified in the Contract, the Department will measure trees and stumps designated for removal according to the following table.

TABLE 201.05-1

Tree or Stump Diameter	Pay Item Designation
Over 12 inches to 24 inches	18-inch size
Over 24 inches to 36 inches	30-inch size
Over 36 inches to 60 inches	48-inch size
Over 60 inches	60-inch size

The Department will measure the diameter of trees at a height of 54 inches above the ground. Trees 12 inches and less in diameter are classified as brush. The Department will measure stumps by taking the average diameter at the cutoff.

201.06 Basis of Payment. If Item 201 Clearing and Grubbing is specified in the Contract, the Department will pay for all work described, including backfilling holes, scalping, and removing all trees and stumps, at the lump sum price bid. If Item 201 Tree Removed or Item 201 Stump Removed is specified in the Contract,

the Department will consider the remaining work described incidental and will not pay for performing this work directly.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
201	Lump Sum	Clearing and Grubbing
201	Each	Tree Removed, ___ Size
201	Each	Stump Removed, ___ Size

ITEM 202 REMOVAL OF STRUCTURES AND OBSTRUCTIONS

202.01 Description. This work consists of removing, entirely or in part, and disposing of all buildings, fences, guardrails, structures, old pavements, abandoned pipe lines, storage tanks, septic tanks, privy vaults, and other obstructions not designated or permitted to remain, except for utilities and obstructions to be removed and disposed of under other items in the Contract. This work also consists of backfilling the resulting trenches, holes, and pits, and salvaging designated materials.

When specific pay items for removal of structures and obstructions are not listed in the Contract Documents, perform this work under Item 203.

202.02 General Construction Requirements. Raze, remove, and dispose of all buildings and foundations, structures, fences, guardrails, old pavements, abandoned pipe lines, storage tanks, septic tanks, privy vaults, and other obstructions within the Right-of-Way, except for utilities and those items where other provisions have been made for removal. Remove and store, at the specified locations within the Project limits, or reuse all designated salvageable materials.

The Department will take ownership of all salvageable items specified for storage. Reuse all salvageable items specified for reuse on the project. When the Contract Documents do not indicate for storage or for reuse, take ownership of the material.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then dispose of the material according to 105.16 and 105.17.

Do not remove any item in use by traffic until after making arrangements to accommodate traffic.

When backfilling is required, backfill the resulting cavities, voids, or trenches with either Item 203 embankment material or Item 611 Structural Backfill Type 1 or 2. Use Item 611 Structural Backfill when the removed item is under the proposed pavement or paved shoulder and when the site limits the use of compaction equipment larger than an 8-ton roller; otherwise the Contractor may use Item 203 embankment material. Place and compact the embankment or Item 611 Structural Backfill according to 203.

For backfilled areas outside the plan construction limits, provide a final grade that presents a neat, well-drained appearance that conforms to the final topography and prevents water from draining onto adjacent properties.

202.03 Structures Removed. Remove bridges, culverts, and other structures indicated for removal in the Contract Documents. If within a stream, remove the substructures of existing structures, including piling, down to the proposed stream bottom. For those parts outside the stream, remove substructures to a minimum of 1 foot below proposed ground surface. Remove, as necessary, those portions of existing structures that lie entirely or partially within the limits for a new structure to accommodate the construction of the proposed structure.

Where alteration of an existing structure requires removal of portions of the structure, remove those portions with sufficient care as to avoid damage to the remaining portion of the structure. In case of damage to the existing structure, repair or replace the structure at no expense to the Department. Remove any existing welded form hangers, welded attachments two inches or longer measured parallel to the long axis of the top flange of steel beams or girders, and welded attachments that interfere with the placement of welded shear connectors.

If removing a bridge or portion of a bridge with an asphalt wearing course, remove the wearing course separately before removing the bridge or portion of the bridge.

Backfill the cavity created by the removal item according to 202.02, except when the cavity lies within the limits of subsequent excavation or other work.

202.04 Pipe Removal. Remove and reuse, store, or dispose of pipe, or culvert, including headwalls, as specified in the Contract Documents.

If removing an existing concrete waterline pipe that was constructed before 1980, it may be an asbestos pipe. Test the pipe by using a Department prequalified environmental consultant to determine if it is an asbestos pipe. If it is determined that the pipe is asbestos, then a certified asbestos Contractor must perform the removal. Dispose of all asbestos pipe at a solid waste facility that is licensed by the Local Health Department and permitted by the OEPA.

Seal openings left in walls of manholes or catch basins that are to remain in place.

If an adjacent existing pipe is encountered during removal operations and the pipe is inactive or is to be abandoned, plug or seal the remaining ends of the pipe before proceeding with backfilling operations. Perform plugging by using approved precast stoppers. Perform sealing by using masonry bulkheads.

Remove a sufficient section of the pipe to allow the Engineer to determine the quality of the pipe and the possibility of its removal without damage to pipe specified for reuse or storage. If the Engineer determines the pipe is salvageable, carefully remove the remainder of the pipe to avoid breaking or damaging the pipe. Transport and store the removed pipe, as necessary before relaying. Replace sections of pipe lost or damaged by negligence or by use of improper methods at no additional cost to the Department. Clean all pipe before reusing. Remove salvageable pipe under Item 202 Pipe Removed for Reuse or Storage.

If the Engineer determines the pipe is unusable, take ownership of the pipe, and dispose of or recycle it according to 202.02. Remove unusable pipe under Item 202 Pipe Removed.

Before backfilling the trench, excavate the caved material, as necessary.

Backfill trenches resulting from the removal of pipe according to 202.02, except when the trench lies within the limits of subsequent excavation or other work.

202.05 Pavement, Walks, Curbs, Steps, Gutters, Concrete Slope Protection, or Traffic Dividers Removed. As designated, remove and dispose of the existing concrete pavement, asphalt pavement, wearing course, brick, walks, steps, gutters, curbs, and concrete traffic dividers. If removing only a portion of an existing pavement, walk, step, gutter, curb, or traffic divider, saw or otherwise construct a neat joint at the removal limit.

If Pavement Removed is specified, remove all pavement layers, including asphalt, concrete, and brick, from the surface to the bottom of the pavement courses as shown on the plans. Pavement Removed does not include removal of any unbound aggregate or natural soil material. If Wearing Course Removed is specified, remove all asphalt from the surface to the top of the concrete, brick, or both, or to the depth shown on the plans. If the existing surface is brick and Wearing Course Removed is specified, remove all brick from the surface. If Concrete Median Removed or Concrete Barrier Removed is specified, remove all the concrete to the depth specified in the plans.

As designated, remove and dispose of the existing concrete slope protection, including tied concrete block mats. If removing only a portion of an existing concrete slope protection, saw or otherwise cut a neat joint at the removal limit if it does not occur at a joint.

Backfill the cavity created by the removal item according to 202.02, except when the cavity lies within the limits of subsequent excavation or other work.

202.06 Buildings Demolished. Do not disturb buildings and appurtenances designated for demolition until the Engineer provides a Notice of Possession and Approval to Proceed. Immediately after receiving approval, schedule and perform the demolition under the Engineer's direction in order to accommodate utility

rearrangements and clearance of structures. Whether the building is located partially or totally on temporary or permanent Right-of-Way perform the demolition the same.

The Contractor may use buildings located partially on and off the permanent Right-of-Way for storage, office, living quarters, or other purposes. The agreement shall allow such use during the period of the Contract and save the Department harmless from any claims whatsoever by reason of such use.

Remove foundations; floors; floor slabs; and basement, pit, well, and cistern walls to a minimum of 1 foot below the grade of the surrounding area.

Completely remove all tanks and clear basements of all materials, debris, appliances, wood or metal partitions, and wood floors so only masonry walls and concrete basement floors remain. Break up and remove all floor slabs under which a pit, well, cistern, or tank exists. Break up basement floors to be left in place, and seal remaining drains with masonry or with precast clay or concrete stoppers.

Take ownership of all materials, except those belonging to a public or private utility. Notify the owners of water, electric, or gas meters when the meters are ready for removal. Disconnect all utilities according to local requirements.

After completing demolition work and obtaining the Engineer's approval, immediately backfill the cavity created by the removal item according to 202.02, except when the cavity lies within the limits of subsequent excavation or other work.

202.07 Septic Tanks and Privy Vaults Removed. Empty all septic tanks and privy vaults. Dispose of the removed contents in a manner that conforms to the requirements of the State and Local Boards of Health or other authorities having jurisdiction.

Completely remove and dispose of septic tanks and privy vaults located above the subgrade or finished ground surface. For septic tanks and privy vaults located below the subgrade or finished ground surface, remove tops and walls to a minimum depth of 3 feet below subgrade or 1 foot below finished ground surface. Break up floors and seal remaining drains with masonry or with precast clay or concrete stoppers.

Backfill the cavity created by the removal, partial removal, or emptying operation according to 202.02, except when the cavity lies within the limits of subsequent excavation or other work.

202.08 Underground Storage Tank Removed. Remove and dispose of underground storage tanks or regulated underground storage tanks, as designated in the Contract Documents, and according to the requirements of the authorities having jurisdiction.

If Item 202 Regulated Underground Storage Tank Removed is specified in the Contract, remove the tank according to the Bureau of Underground Storage Tank Regulations of the Division of Fire Marshal (BUSTR), Ohio EPA, and all applicable Federal, State, and local regulations. Removal includes obtaining the required permit, disposing of the tank and its contents, testing the excavated material, and preparing the closure report. Provide a Certified Tank Installer to supervise the removal. Provide an independent non-Contractor employee BUSTR inspector or a

State Certified BUSTR inspector to perform the BUSTR required inspections. For tanks containing hazardous substances other than petroleum, use the Ohio EPA regulations in addition to State Fire Marshal regulations.

Completely remove regulated underground storage tank and contents. Take ownership and dispose of tanks according to 202.02 and the above requirements. If because of leakage from the tank, any contaminated water or soil disposal or remediation is required, perform the necessary work under other items in the Contract or according to 109.05.

If Item 202 Underground Storage Tank Removed is specified in the Contract, completely remove and dispose of the tank. Dispose of the removed contents in a manner that conforms to the requirements of the State and local Boards of Health, or other authorities having jurisdiction.

Backfill the cavity created by the removal items according to 202.02, except when the cavity lies within the limits of subsequent excavation or other work.

202.09 Guardrail and Fence Removed. Carefully dismantle and store existing guardrail (including anchor assemblies and terminal assemblies, and any attached posts, signs, and delineators) and fence when designated for reuse or storage by the Department. Dispose of wood posts and other materials not considered salvageable according to 202.02.

When fence is designated for replacement, do not remove the existing fence until the replacement material is on site. Begin the new installation within 7 workdays of beginning the removal process.

When guardrail is designated to be replaced and traffic is being maintained in the adjacent lane, do not leave hazards unprotected except for the actual time required to remove the existing guardrail and install the proposed guardrail in a continuous operation. Do not remove the guardrail until the replacement material is on the site and ready for installation. The Engineer will suspend work for failure to comply with this requirement.

Backfill the cavity created by the removal item according to 202.02, except when the cavity lies within the limits of subsequent excavation or other work.

202.10 Manhole, Catch Basin, and Inlet Removed. Remove existing drainage structures of the types designated for removal. Take ownership of castings unless otherwise noted on the plans.

Backfill the cavity created by the removal item according to 202.02, except when the cavity lies within the limits of subsequent excavation or other work.

202.11 Manhole, Catch Basin, and Inlet Abandoned. Remove existing drainage structures of the types designated to be abandoned to a minimum of 1 foot below the finished subgrade or ground surface. Do not damage pipes that are to remain. Take ownership of castings unless otherwise noted on the plans.

Connect existing pipes with new pipe through the structures. Seal the existing inlet and outlet pipes with precast vitrified or concrete stoppers or with masonry of a type and thickness to fill the inlet or outlet pipe.

After connecting or sealing the existing pipes and removing the walls to the required depth, backfill the remaining cavities according to 202.02. If using connecting pipes, carefully hand tamp backfill under and around the pipe according to 202.02.

202.12 Method of Measurement. If the Contract specifies that removal of structures and obstructions is on a lump sum basis, the work will include all structures or obstructions encountered at locations or within areas designated in the Contract Documents. However, the Department will measure asphalt wearing course removal on a bridge separate from the lump sum item for structure removal.

If the Contract specifies that removal of specific items is on a unit basis, the Department will measure the quantity of each item by the unit stipulated in the Contract. If removal of steps is measured by the foot, the Department will measure the number of feet along the front edge of each tread. If the steps have an integral wall, the Department will include the thickness of the integral wall with the tread width measurement.

202.13 Basis of Payment. Payment is full compensation for all work involved in the removal and storage, reuse, or disposal of structures and obstructions, including excavation and backfill incidental to their removal, saw cutting, removing the contents of the underground storage and septic tanks and the custody, preservation, storage on the Right-of-Way, and disposal as provided in this specification.

For pipe removed and reused or stored, the Department will pay for the accepted work under Item 202 Pipe Removed for Reuse or Storage. For unusable pipe removed, the Department will pay for the accepted work under Item 202 Pipe Removed.

If the Contract Documents do not include a pay item for Item 202 Asbestos Pipe Removed, then the Department will pay for removal and disposal of asbestos pipe according to 109.05.

When removed pavement is replaced with embankment material, the Department will pay for the embankment material under the applicable 203 or 204 pay item. When pipe is removed from beneath existing pavement, the Department will pay for pavement removal under the applicable pay item for pavement removal or excavation, and the Department will pay for new pavement under the applicable pavement pay item.

Include all of the costs and work associated with compliance of the rules or regulations under Item 202 Regulated Underground Storage Tank Removed. If the underground storage tank is not regulated, the work does not include obtaining inspection services, permits, testing excavated material, or closure reporting and the payment will be under Item 202 Underground Storage Tank Removed.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
202	Lump Sum	Structure Removed
202	Lump Sum, or Cubic Yard or Pound	Portions of Structure Removed

202	Foot	Pipe Removed for Reuse or Storage
202	Foot	Pipe Removed
202	Foot	Asbestos Pipe Removed
202	Square Yard	Pavement Removed
202	Square Yard	Wearing Course Removed
202	Square Foot	Walk Removed
202	Lump Sum, or Foot	Steps Removed
202	Foot	Curb Removed
202	Foot	Curb and Gutter Removed
202	Foot or Square Yard	Gutter Removed
202	Square Yard	Concrete Median Removed
202	Foot	Concrete Barrier Removed
202	Square Yard	Concrete Slope Protection Removed
202	Lump Sum	Building Demolished
202	Each	Underground Storage Tank Removed
202	Each	Regulated Underground Storage Tank Removed
202	Each	Septic Tank Removed
202	Each	Privy Vault Removed
202	Foot	Guardrail Removed
202	Foot	Guardrail Removed for Reuse or Storage
202	Foot	Fence Removed for Reuse or Storage
202	Each	Manhole Removed
202	Each	Manhole Abandoned
202	Each	Catch Basin or Inlet Removed
202	Each	Catch Basin or Inlet Abandoned

ITEM 203 ROADWAY EXCAVATION AND EMBANKMENT

203.01 Description. This work consists of preparing areas upon which embankments are to be placed; excavating for roadways and channels, including the removal of all material encountered not being removed under another item; constructing embankments with the excavated material and material from other

approved sources as necessary to complete the planned embankments; furnishing and incorporating all water required for compacting embankment; disposing of unsuitable and surplus material and finishing shoulders, slopes, and ditches.

All excavation is considered unclassified excavation. If the excavation contains regulated materials such as garbage, solid waste, and hazardous waste or material, the Contract Documents will detail the removal for these items.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

203.02 Material Definitions.

A. Asphalt Concrete. Reclaimed asphalt pavement (RAP) that is blended to meet the requirements in 703.16.

C. Borrow. Material obtained from approved sources, located outside the construction limits that is required for the construction of the embankment. When borrow is specified or used, use suitable materials that conform to 203.02.R.

D. Compaction Testing. The Department will perform the compaction testing of embankment and subgrade according to Supplement 1015.

E. Embankment. A structure consisting of suitable materials conforming to 203.02.R and constructed in lifts to a predetermined elevation and cross section.

F. Excavation. The excavation and disposal of all materials required by the Contract Documents.

G. Maximum Dry Density. The maximum dry density is determined according to AASHTO T 99, AASHTO T 272, or Supplement 1015. The Department will use this maximum dry density for compaction acceptance.

H. Natural Granular Materials. Natural granular materials include broken or crushed rock, gravel, sand, durable siltstone, and durable sandstone that can be placed in an 8-inch loose lift.

I. Natural Soil. All natural earth materials, organic or inorganic, resulting from natural processes such as weathering, decay, and chemical action.

J. Optimum Moisture Content. The water content at which the maximum dry density is produced in an embankment material. The optimum moisture content is determined according to AASHTO T 99, AASHTO T 272, or Supplement 1015.

K. Petroleum Contaminated Soil (PCS). Petroleum contaminated soil (PCS) that is regulated under OAC-1301:7-9-16.

L. Random Material. Mixtures of suitable materials that can be placed in 8-inch (200 mm) loose lifts.

M. Recycled Portland Cement Concrete. Recycled Portland cement concrete (RPCC) that is blended to meet the requirements in 703.16.

N. Recycled Materials. Fly ash, bottom ash, foundry sand, recycled glass, tire shreds, or other materials or manufacturing byproducts not specifically named as suitable materials in 203.02.R.

O. Rock. Sandstone, siltstone, limestone, dolomite, glacial boulders, brick, and RPCC too large to be placed in an 8-inch loose lift.

P. Shale. A fine-grained sedimentary rock formed from the lithification of clay, silt, or mud. Shale has a laminated structure, which splits easily (is fissile). For the purpose of this specification, mudstone and claystone are also considered to be shale. Shale is classified as durable or nondurable according to 703.16.D.

Q. Slag Materials. Slag materials include air cooled blast furnace slag (ACBFS), granulated slag (GS), open hearth (OH) slag, basic oxygen furnace (BOF) slag, and electric arc furnace (EAF) slag meeting the requirements in 703.16.

R. Suitable Materials. All suitable materials are restricted in 203.03. Furnish soil or embankment material conforming to 703.16, when Item 203 Embankment is specified. Furnish material that conforms to 703.16.B or 703.16.C when Item 203 Granular Embankment is specified. Furnish material that conforms to 703.16.C when Item 203 Granular Material Types A, B, C, D, E or F are specified. Do not use recycled materials unless specifically allowed by the Supplemental Specifications.

203.03 Restrictions on the Use of Embankment Materials. Suitable materials are further restricted as follows:

A. Use silt identified as ODOT Group Classification A-4b and RAP only if placed at least 3 feet below the surface of the subgrade.

B. Do not place RPCC and RAP in any location where it would inhibit the growth of vegetation.

C. Do not use any suitable material that cannot be incorporated in an 8-inch lift in the top 2 feet of the embankment.

D. Do not use nondurable shale in the top 2 feet of the embankment that is not completely compacted and pulverized into a soil with 100 percent of the material passing the No. 4 sieve.

E. If using RPCC, OH slag, EAF slag, BOF slags, or blends of these materials, place these materials at least 1 foot below the flow line of the underdrains.

F. Do not use RPCC, OH slag, EAF slag, BOF slags, granulated slag, or blends of these materials for underwater applications.

G. Do not use materials that cannot be satisfactory placed and compacted to a stable and durable condition.

H. Material excavated in the work that contains excessive moisture is unsuitable for embankment construction unless dried. Dry or aerate such material before incorporating in the work. The Contractor may elect to waste this material, instead of drying it.

I. If Granular Material Type E in 703.16.C is allowed or specified, use a geotextile fabric conforming to 712.09, Type D on the top, bottom, and around the Type E material to prevent piping of the material into the Type E material.

J. If electing to use PCS, submit the information stated below in a suitable format at least 10 workdays before the intended usage.

1. Have an ODOT prequalified consultant, in environmental site assessment and remediation, review the proposed usage. The consultant shall randomly monitor the construction to ensure that the environmental requirements are carried out on the project. The consultant shall report any discrepancies to the Department and the Contractor. The consultant shall certify the report or reports to the Department.

2. Use PCS that conforms to all current environmental policies, rules, and regulations under OAC 1301: 7-9-16. Perform sampling and testing on every 100 tons of PCS used.

203.04 General. Perform the required clearing and grubbing before starting the excavation, grading, and embankment operations.

Coordinate the clearing and grubbing with the installation of sediment and erosion controls.

Remove all existing pavement before the embankment construction.

Temporarily discontinue operations when the excavating operations encounter remains of prehistoric archaeological sites, historical archaeological sites, or human remains. The Engineer will contact the Department's Office of Environmental Services to determine the disposition thereof. Preserve the artifacts or other archeological items or human remains until a determination as to what the disposition and/or removal of such items is made by the Office of Environmental Services. Such excavation is considered Extra Work.

If the Contractor encounters any abnormal material such as, but not limited to, drums, tanks, or stained earth or any unusual odors during construction operations, the Contractor shall temporarily discontinue the work in this area, leave equipment in place, cordon off the area, and notify the Engineer. The area is considered to contain hazardous waste or material and must be handled according to Department procedures and appropriate environmental agency regulatory requirements. Upon notification by the Engineer to resume work, the Contractor may file for an extension of time according to 108.06.

A. Drainage and Maintenance of the Work. Maintain a well-drained embankment and excavation operation. If trenching for narrow widening and in other areas of the embankment construction, construct ditches of an adequate depth and at frequent intervals across the berm or embankment to maintain drainage. Deepen side ditches when necessary to ensure thorough embankment or subgrade drainage.

Construct the embankment with sufficient cross-slope to drain in case of rain.

If precipitation saturates the embankment construction, stay off the embankment construction until the embankment dries or stabilizes. Expedite the construction by removing the saturated embankment or dry the embankment by scarifying, plowing, disking, and recompacting the embankment.

Throughout the embankment construction operation and at the end of each day's operation, shape to drain, compact, and recompact the work area to a uniform cross section. Eliminate all ruts and low spots that could hold water.

If using embankment construction or cut areas to haul on, continuously move the hauling equipment around on the area to take advantage of the compactive effort. Continually re-grade and compact the haul roads and maintain the construction according to 105.13 and 105.14.

Plug and cover the upstream ends of all pipe lines encountered during earthwork operations.

B. Rock or Shale Blasting Operations. Conform to Item 208 when blasting.

C. Slides and Breakages. Remove all slides and breakages beyond the limits of the planned finished work when caused by improper excavation methods.

D. Shoulders, Slopes, and Ditches. When specified, place the topsoil in areas to be seeded or sodded according to Item 659. Build shoulders to the lines shown on the plans and to the tolerances specified in 203.08. Reshape shoulders, slopes, and ditches that have been damaged by erosion during construction.

Keep new and existing pavement, and the paved area of the berm clear of earth stockpiles or other berm materials.

F. Borrow. Unless otherwise designated in the Contract, make arrangements for obtaining borrow and pay all costs involved. If borrow is specified, use all suitable excavated material in the work prior to using the borrow material.

Place borrow used as embankment according to all the requirements for constructing embankment.

Blade and leave all borrow areas in such shape as to allow accurate measurements after the excavation has been completed.

Notify the Engineer sufficiently in advance of opening any borrow areas so that cross section elevations and measurements of the ground surface after stripping may be taken.

Construct borrow areas that conform to 105.16; clean up the borrow areas according to 104.04.

G. Staged Construction and Waiting Periods. If specified in the Contract Documents, control the rate of fill accordingly. Adhere to the rate of fill and to the waiting periods during the work.

203.05 Embankment Construction Methods. Embankment construction includes preparing areas upon which embankments are to be placed; placing and compacting approved material within roadway areas where unsuitable material has been removed; and placing and compacting approved material in holes, pits, and other depressions within the roadway.

If scalping is required, scarify, plow, disk, and compact the existing embankment foundation. Compact the top 8 inches of the foundation to 95 percent of the maximum dry density or to a maximum test section dry density according to Supplement 1015. If the foundation cannot be compacted, the Department will

design replacement material or the Engineer may increase the lift thickness of the next layer of embankment.

The Engineer may increase the lift thickness of the next embankment layer to bridge the soft or wet foundation areas that will not support the weight of the trucks or hauling equipment. Dump successive loads of rock, durable shale, or granular material in a uniform lift. Do not exceed the thickness required to support the equipment placing the material. Manipulate, blade, distribute, level, and doze the material in place until the area is stabilized and material is above the normal water elevation. Once the bridging has been accomplished, construct the remaining lifts according to 203.06.

If the existing slope is steeper than 8:1, bench into the existing slope as follows:

A. Scalp the existing slope according to Item 201.

B. Cut horizontal benches in the existing slope to a sufficient width to blend the new embankment with the existing embankment and to accommodate the placement, and compaction operations and equipment.

C. Bench the slope as the embankment is placed, and compact into layers.

D. Begin each bench at the intersection of the existing slope and the vertical cut of the previous bench. Recompact the cut materials along with the new embankment.

If constructing embankment on only one side of abutments, wing walls, piers, or culvert headwalls, construct the embankment so that the area immediately adjacent to the structure is not compacted in a manner that causes overturning of or excessive pressure against the structure. If constructing embankment on both sides of a concrete wall, pipe, or box type structure, construct the embankment so that the elevation on both sides of the structure is always approximately the same.

203.06 Spreading and Compacting. Do not construct frozen embankment material or place embankment material on frozen ground.

Spread all embankment material, except for rock in 203.06.C. and RPCC in 203.06.D, in successive horizontal loose lifts, not to exceed 8 inches in thickness. Compact all embankment material lifts, except for Type D granular material, Type E granular material, rock and durable shale, to the specified density and moisture controls in 203.07.

When a minimum effective weight requirement is specified in 203.06 or 203.07, the Contractor may use a vibratory roller which meets the requirement using a combination of weight and equivalent centrifugal force from vibration. In all cases, submit documentation from the manufacturer that shows the roller meets the minimum effective weight requirements.

The Engineer may reduce the minimum number of passes if additional passes are detrimental to compaction or stability.

A. Soil and Granular Embankment. Use a footed drum roller having a minimum effective weight of 10 tons to compact cohesive soil, except that the Contractor may use a smooth drum vibratory roller if the quantity of embankment is 75 cubic yards or less and the roller is operating on a slope no steeper than 4:1.

For soil or granular material, when a test section is used, use a minimum compactive effort of eight passes with a steel drum roller having a minimum effective weight of 10 tons.

Compact Type D and Type E granular material using at least ten passes of a smooth drum vibratory roller having a minimum effective weight of 10. Add water to Type D granular material as needed or directed by the Engineer.

B. Shale. The Engineer will test shale for durability according to 703.16.D, to determine if compaction testing is required. For nondurable shale, when a test section is used, use a minimum compactive effort of ten passes with a footed drum roller having a minimum effective weight of 15 tons or with rollers meeting the requirements of 703.16.D.

Use water to aid in breaking down large particles and to bring the shale to at least 2 percent above optimum moisture content.

Compact durable shale, as defined in 703.16.D, with a minimum compactive effort of ten passes of a footed drum roller having a minimum effective weight of 15 tons or with rollers meeting the requirements of 703.16.D. When durable shale is mixed with fine material, use fine material that is at least 2 percent above optimum moisture content. No density testing will be required. If shale mixtures contain large particles of shale, break down the particles during placement until the voids are filled.

Place and compact shale and rock mixtures using the same procedure as for shale. Reduce rock size in a shale-rock mixture to less than or equal to 8 inches, or separate rock greater than 8 inches from the mixture and use as rock fill. Use the construction methods for rock when the shale-rock mixture contains less than 15 percent shale.

C. Rock. Reduce the rock until it is small enough to be incorporated into the following horizontal lift thickness: Place rock in a maximum loose lift thickness 6 inches larger than the largest diameter of the rock pieces or 3 feet, which ever results in the smaller lift thickness. When placing rock fill within a length of six times the height of the fill at an abutment, place rock fill in loose lifts not to exceed 18 inches. [For example, if the fill height is 20 feet, then the rock fill within 120 feet of the abutment is placed in less than 18-inch loose lifts.]

Do not dump the rock, but distribute and place the full width of the lift by blading or dozing to ensure proper placement. Evenly distribute the larger rocks, and reduce the voids, pockets, and bridging to ensure minimum deformation. Incorporate smaller rock pieces in the upper portions of each rock lift to fill the voids during this manipulation.

When placing embankment material other than rock on top of the rock lift, level and smooth the rock surface using suitable leveling equipment and evenly distribute the smaller rock, rock spalls, or finer rock fragments.

Roll all rock lift surfaces with eight passes of a vibratory footed drum roller having a minimum effective weight of 10 tons.

When constructing rock and other embankment materials at approximately the same time, perform the following:

1. Use the rock at the base of the embankment.

2. Use rock in the outer portions of the embankment.

3. Use the larger rocks on the outside side slopes.

4. Use the other embankment material in the inner portion of the fill.

5. Keep the top of the other embankment materials higher than the rock.

6. Construct the other embankment materials to a sufficient width to allow the specified compaction.

7. When rock is placed on top of other embankment material, construct the other embankment material at a center-to-side slope grade of approximately 4 percent.

D. Random Materials. Reduce the random material until it is small enough to incorporate into an 8-inch lift, except for RPCC in 203.06.D.1 through 203.06.D.4.

When using a uniformly graded mixture, use material with a moisture content less than 2 percent below optimum to obtain compaction. When large pieces are incorporated in the lifts, use fine material with a moisture content less than 2 percent below optimum to obtain compaction.

Compact natural soil and natural granular material blends with RAP or RPCC to the same requirements as a granular embankment in 203.06.

When using RPCC slabs or large RPCC pieces in the embankment construction, conform to the following:

1. Use natural soil or natural granular material that is less than 2 percent below optimum moisture content in the blend. Reduce the slabs or pieces to less than 3 × 3 feet in size and place the blend in a maximum loose lift thickness of 12 inches.

2. Manipulate, level, and distribute the mixture by blading or dozing to fill the voids and pockets, and reduce bridging.

3. Compact the natural soil or natural granular embankment to the compaction and moisture requirements in 203.07.

4. When the RPCC slabs or large RPCC pieces consists of more than 50 percent of the embankment lift, place the blended material in maximum loose lifts of 18 inches. Do not place one slab directly on the other. Compact, manipulate, level, and distribute as stated in 203.06.D.1 through 203.06.D.3.

E. Areas Inaccessible to Rollers. For areas inaccessible to rollers, such as adjacent to culverts, retaining walls, or other structures, construct the embankment in 6-inch horizontal loose lifts.

203.07 Compaction and Moisture Requirements. Construct all embankments, except rock and durable shale, using moisture and density controls. Unless otherwise specified in the Contract Documents, the Engineer will perform all compaction tests according to Supplement 1015.

A. Moisture Controls. Sprinkle enough water on embankment material that contains too little moisture to wet it to a moisture content needed to meet the density

requirements. Apply the water using tank trucks equipped with suitable sprinkling devices. Thoroughly incorporate the water into the material by using discs, plows, or other approved equipment. Continue to water and to manipulate until the required moisture is uniformly distributed throughout the lift.

Before or during compaction, allow the embankment material that contains excess moisture to dry to a moisture content needed to meet the density requirements. Continue drying until the required moisture is uniform throughout the lift. However, for material that displays pronounced elasticity or deformation under the action of loaded rubber tire construction equipment or other equipment, reduce the moisture content to secure stability. Expedite and manipulate the embankment material by drying the wet embankment material by using plows or discs; by adding dry material, lime, lime kiln dust, or cement; or by other methods.

Do not mix shale in the lifts to reduce the moisture content of the embankment material.

B. Compaction Requirements. Compact all embankment materials, except for rock and durable shale, in horizontal lifts to a dry density greater than the percentage of maximum dry density in Table 203.07-1, or to 98 percent of the maximum dry density determined by the test section methods specified in Supplement 1015.

TABLE 203.07-1 EMBANKMENT COMPACTION REQUIREMENTS

Maximum Dry Density [lb/ft³]	Minimum Compaction Requirements in Percent of Maximum Dry Density
90 to 104.9	102
105 to 119.9	100
120 and more	98

If needed for compaction acceptance, construct a test section using the following:

1. Use at least the same number of passes and compactive effort used to construct the test section to construct the production embankment areas.

2. Construct a new test section when the material, supporting foundation, or embankment changes.

3. Reduce the moisture content if the material becomes unstable.

203.08 Earthwork Construction Tolerances. Finish the completed excavation and embankment to the cross sections shown on the plans. Check the excavation and embankment work with templates, slope boards, electronic methods, or other methods specified in Item 623. The Engineer will allow occasional deviations in the work within the following tolerances:

A. When topsoil is specified, use the following:

1. In fill areas, construct the embankment to the bottom of the topsoil depth.

2. In cut areas, excavate additional depth to allow for the topsoil.

3. For cuts or fills, the cross sections show the finished grade, which is the top of the topsoil.

B. For the backslopes (cut slopes), from the back of the ditch to the existing ground, and for the foreslopes (fill slopes), from the edge of the graded shoulder to the bottom of the ditch, do not allow deviations greater than 1 foot as measured in the horizontal plane.

C. Do not construct shoulders and ditches less than the horizontal measurement from the centerline or to a higher elevation than shown on the plans. However, the cross section may vary below the plan grades by less than 1/2 inch at the pavement edge and by less than 2 inches elsewhere.

D. Construct or fine grade the subgrade to within 1/2 inch of the plan elevation at any location. Construct or fine grade the subgrade to within 1/2 inch of the plan grade as measured with a 10-foot straightedge applied to the surface parallel to the centerline of the pavement.

E. For all rock or shale cut slopes that do not require control blasting techniques, rake excavate, hoe ram, or mechanically shape these slopes to obtain a neat and smooth appearance.

203.09 Method of Measurement. The Department will measure Excavation by the number of cubic yards of material in the original position, acceptably excavated, using the average end area method.

The Department will measure Embankment; Rock; Granular Embankment; and Granular Material, Type ___ by the number of cubic yards of material in the final position, acceptably placed, using the average end area method.

Measurement will include overbreakage or slides not attributable to carelessness of the Contractor, embankment settlement caused by soft embankment foundation, unsuitable materials excavated and removed to obtain proper stability in cut sections and in foundation areas for fill sections.

The Department may use three-dimensional measurements where it is impractical to measure material by the cross section method due to the erratic location of isolated deposits.

The Department will not measure excavation or embankment outside plan limits.

The Department will measure Borrow by the cubic yard or ton as specified in the Contract Documents.

The Contract Documents will specify borrow only when the measurement of the material in its final location by volume is impractical. For example, this would apply when the borrow material is to be placed in locations that are under water or in locations with extremely soft foundations. In addition, the Department may specify borrow when additional material is needed and when Item 209 is specified. In this case, the Department will pay for borrow under 209 Borrow.

The Department will measure the volume of borrow material in a natural formation either by the average end area method or by weight.

Where measurement is by the average end area, the Department will take cross sections after the surface has been cleared and scalped and again after the borrow area excavation has been completed. The cross sections determine the volume for payment.

Where the total weight is measured and converted to volume, the Department will determine material density in pounds per cubic yard in its original position by a series of representative field measurements made after clearing and scalping have been performed, and as the excavation exposes the borrow material. Weigh the acceptable material, minus excess moisture, excavated from the borrow area for incorporation into the embankment, and furnish the Department with load slips. The Department will determine the cubic yards for payment by dividing the total weight of the borrow material by the average weight per cubic yard of the undisturbed material. If the moistures of the in-place borrow site density test material is not within 2 percent of the accepted delivered material, the Department will calculate volume based on the dry densities and weights.

The Department will calculate the volume of borrow from sources other than natural in-place formations, such as processed slag, sand, stone or gravel, and quarry material as follows: Determine the material in-place compacted density in pounds per cubic yard. The volume paid will be the total weight of the material furnished, minus excess moisture, divided by 95 percent of the average embankment density. If the moisture content of the accepted in-place density test material is not within 2 percent of the delivered material, the Department will calculate volume based on the dry densities and weights. Where measurements show that completed embankment exists outside the plan cross sections or outside the allowable tolerances, the Department will multiply the quantity outside plan lines by a shrinkage factor to determine the quantity deducted from the measured borrow quantity. The shrinkage factor is determined by dividing the volume or weight of the material excavated or used as borrow by the volume or weight of the material compacted in place.

When the measurement is by weight, the Department will accept the material based on the freight bills and weight and volume evidence according to 109.

203.10 Basis of Payment. If the Contract does not include 201 Clearing and Grubbing or an estimated quantity for 201 Tree Removed or 201 Stump Removed, or an estimated quantity for the pay items under Item 202, the Department will not pay for this work directly but will considered it incidental to pay items under Item 203.

The Department will not pay for additional wasting cost of material excavated in the work that was wasted instead of being dried as detailed in 203.03.H.

If the Contractor elects to use PCS, the Department will not pay for additional work necessary to comply with the requirements specified in 203.03.J.

If during excavation the Contractor encounters remains of prehistoric archaeological sites, historical archaeological sites, or human remains, the Department will pay for such excavation according to 109.05.

If during excavation the Contractor encounters hazardous material or waste, the Department will pay according to 109.05.

If necessary during the construction in 203.03.H, 203.04.A, or 203.07.A, the Department will not pay for removing the saturated embankment or drying the embankment.

If caused by improper excavation methods, the Department will not pay for removing slides and breakages beyond the limits of the planned finished work. The Department will pay for the removal of slides and breakages beyond the limits of the planned finished work according to 109.05, when there is no Contractor fault or neglect.

If caused by the lack of implementing erosion controls, the Department will not pay for reshaping shoulders, slopes, and ditches damaged by erosion during construction.

If caused by the Contractor's equipment or methods, the Department will not pay for repairing or restoring damaged areas designated for salvage.

When topsoil is specified, the Department will not make deductions or additions from the earthwork quantities for the topsoil.

The Department will not adjust earthwork quantities when the volume between two consecutive cross-sections differs by less than 5 percent from the plan quantity, unless the difference between the actual quantity and plan quantity is greater than 1000 cubic yards for all pay items measured by the cubic yard under Item 203, combined. For quantity differences greater than 5 percent or greater than 1000 cubic yards, submit supporting documentation to the Engineer. However, the Department will adjust earthwork quantities for changes less than 5 percent or 1000 cubic yards when the change results from the following: undercutting, foundation settlement, changes to grades or slopes, and removing slides. For quantities measured for payment, the Department will use the plan cross sections, corrected for errors, as the original field cross sections. Additional cross sections may be interpolated from the plans at points necessary to more accurately determine quantities.

The Department will pay according to 109.05 for changes or extra work that increases the haul distance more than 1/2 mile to the work detailed in the Contract Documents. The Department will pay for additional quantities that increase the haul distance 1/2 mile or less at the unit bid price.

When specified, the payment for borrow includes all work to complete the embankment construction to the cross sections shown on the plans. The Department will not make additional payment for the embankment construction of the borrow material. When borrow is not specified, all work is included in the excavation or embankment pay items.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
203	Cubic Yard	Excavation
203	Cubic Yard	Embankment
203	Cubic Yard or Ton	Granular Embankment
203	Cubic Yard or Ton	Granular Material, Type ___
203	Cubic Yard or Ton	Borrow
203	Cubic Yard or Ton	Rock

ITEM 204 SUBGRADE COMPACTION AND PROOF ROLLING

204.01 Description. This work consists of preparing suitable subgrade material by drying, compacting, proof rolling, and grading. This work also consists of removing unsuitable subgrade material and constructing new embankment to the limits shown on the plans.

The contract documents provide the anticipated amount of excavation for unsuitable subgrade material which includes unsuitable soil, rock, shale, and coal in the subgrade, and for unstable subgrade material.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

204.02 Materials. Furnish suitable material conforming to 203.02.R, 203.03, and 703.16, except use soils in the top 12 inches of the subgrade that have a maximum dry density of at least 100 pounds per cubic foot.

Furnish material that conforms to 703.16.B or 703.16.C when Granular Embankment is specified. Furnish material that conforms to 703.16.C when Granular Material, Type ___ is specified, except do not use RPCC, EAF slag, or BOF slag.

Do not use Granular Material Type D, E, or F in the location where underdrains are to be constructed.

Furnish geotextile fabric that conforms to 712.09, Type D.

Furnish geogrid that conforms to 712.15.

204.03 Compaction of the Subgrade. Compact subgrade materials that have a maximum dry density of 100 to 105 pounds per cubic foot to not less than 102 percent of maximum dry density. Compact all other subgrade materials to not less than 100 percent of maximum dry density. Determine the maximum dry density using AASHTO T 99, AASHTO T 272, or test section method described in Supplement 1015, according to the Engineer. Unless otherwise specified in the Contract Documents, the Engineer will perform all compaction tests according to Supplement 1015. The Department may check for compaction before or after the fine grading operation.

If needed for compaction acceptance, use the test section method as follows:

A. Use a minimum of eight passes with a steel drum roller having a minimum effective weight of 10 tons.

B. Use 98 percent of the test section maximum dry density for acceptance of the production subgrade compaction.

C. Use at least the same number of passes and compactive effort used to construct the test section for the production subgrade compaction.

D. Construct a new test section when the subgrade material, supporting foundation or embankment material changes.

E. Reduce the moisture content if the material becomes unstable. The Engineer may reduce the minimum number of passes if the passes are detrimental to compaction.

Use the moisture controls specified in 203.07.A.

Compact the subgrade under pavements to a depth of 12 inches below the subgrade surface and 18 inches beyond the edge of the surface of the pavement, paved shoulders, or paved medians. Compact all subgrades under paved driveways, paved mailbox turnouts, curbs and gutters to a depth of 12 inches below the subgrade surface.

Maintain and drain the subgrade according to 203.04.A.

204.04 Unstable Subgrade. If satisfactory subgrade stability cannot be obtained by moisture control and compaction according to 204.03, the Engineer will direct the Contractor to remove the unstable material and to construct the replacement material to the finished grade within the tolerances specified in 203.08.

Conduct the removal and replacement operations to allow the Engineer to measure the cross-sections before placing the replacement material.

Remove the unstable subgrade material to the depth determined by the Engineer or specified in the Contract Documents. Replace with suitable material according to 204.07.

204.05 Rock, Shale, or Coal Subgrade. If an aggregate base is not a part of the pavement design, excavate the subgrade 2 feet below the final subgrade elevation where rock, shale, or coal is encountered. If an aggregate base is part of the pavement design, reduce the above 2-foot excavation depth by the thickness of the aggregate base or bases. Maintain a total excavation depth of 2 feet below the bottom of the asphalt or concrete pavement.

Excavate for a width of 1 foot beyond the shoulders. Replace with suitable material according to 204.07.

204.06 Proof Rolling. Test the stability and uniformity of the subgrade compaction by proof rolling.

A. Use a proof roller conforming to the following:

1. Four heavy pneumatic tire wheels mounted on a rigid steel frame.

2. Wheels evenly spaced in one line across the width of the roller.

3. Wheels arranged so that all wheels carry approximately equal loads when operated over an uneven surface.

4. A maximum center-to-center spacing between adjacent wheels not exceeding 32 inches.

5. A body for ballast loading capable of varying the gross load from 25 to 50 tons.

6. Tires capable of operating at inflation pressures ranging from 90 to 120 pounds per square inch. Provide a tire pressure gage for measurement before use.

7. Tires filled with liquid from 90 to 95 percent by volume.

Provide ballast that consist of blocks of known weight, sand bags with a weight of 100 pounds, bags of other material of known weight, or other suitable material such that the total ballast weight is readily determinable at all times. Provide sufficient ballast to load equipment to a maximum gross weight of 50 tons.

Furnish the Engineer information verifying that the weights and tire pressures can be met.

B. After compacting the subgrade according to 204.03 and before placing overlying course, proof roll designated subgrade areas. If proof rolling is performed after the underdrains are installed, do not use the proof roller within 1 1/2 feet of the underdrains.

Ensure that the subgrade moisture content at the time of proof rolling is within 2 percent of the moisture used for acceptance in 204.03.

Adjust the load and tire inflation pressure as directed by the Engineer or according to the following:

1. For soils classified as A-3, A-4, A-6, or A-7-6, use a 35-ton roller with a tire pressure of 120 pounds per square inch.

2. For granular soils, and soil, rock, and granular mixtures, use a 50-ton roller with a tire pressure of 120 pounds per square inch.

3. When proof rolling areas where unsuitable or unstable subgrade materials have already been excavated and replaced with granular material, use the weight and tire pressure appropriate for the original subgrade material type.

Measure the tire pressure in the presence of the Engineer. Operate equipment at a speed between 2 1/2 and 5 miles per hour. Adjust the speed to allow the Engineer to measure the deflections, ruts, or elasticity. Make only one trip of the proof roller over any area. Offset trips to completely cover the subgrade area.

Where proof rolling indicates areas of unstable subgrade, the Engineer will investigate for the source of the problem. The Contractor is responsible for all problems found in the materials constructed under the Contract Documents. Correct all deficiencies found. Correct the subgrade to a uniform and satisfactory stability as directed by the Engineer.

After proof rolling, check the subgrade for conformance to the plans, and correct all surface irregularities. Shape the subgrade within the tolerances specified in 203.08.

204.07 Spreading and Placing of Materials. Place materials, conforming to 204.02, in 8-inch loose lifts. The Engineer may increase the lift thickness depending on the stability of the bottom of the excavation. The Engineer may increase the lift thickness up to 24 inches to obtain stability at the top of the lift. Doze, track, or manipulate the material to maximize the density and stability. Once stability is achieved, compact according to 204.03.

A. Geotextile. When specified, place geotextile fabric at the bottom of the undercut or at locations designated in the Contract Documents. Place the geotextile fabric smooth and free of tension or wrinkles. Fold or cut the geotextile fabric to conform to curves. Overlap a minimum of 18 inches at the ends and sides. Hold the geotextile fabric in place with pins or staples.

End dump the suitable material on the geotextile fabric. Do not operate the equipment directly on the geotextile fabric. Unless stated otherwise, spread the end dumped material and maintain a minimum lift thickness of 12 inches.

When granular material Type E is specified or allowed, use a geotextile fabric on the top, bottom and around the Type E granular material to prevent piping of material into the Type E granular material. The Engineer may use granular material Type E when excess water is at the bottom of the undercut.

B. Geogrid. When specified, place geogrid at the bottom of the undercut or at locations designated in the Contract Documents. The geogrid may be attached to the underlying geotextile fabric when both materials are placed at the bottom of the excavation.

Roll out the geogrid longitudinally along the roadway, in line with the placement of the granular fill. Do not drag the geogrid across the subgrade. Place the geogrid smooth and free of wrinkles. Hold the geogrid in place with pins, staples, sandbags or piles of granular material to prevent movement during granular fill placement..

Cut the geogrid to conform to curves. Folding over the excess portion of the geogrid into the fill may be used as an alternative to cutting, if acceptable to the Engineer. Maintain the vertical position of the geogrid at the specified depth.

Overlap geogrid a minimum of 2.0 feet at the ends and sides. Overlap geogrid 3.0 feet in all directions if foot traffic causes movement of the subgrade. Place the beginning of each new roll beneath the previous roll to prevent the advancing fill from lifting the geogrid. Stagger end overlaps at least 10 feet from other end overlaps in adjacent rolls or consecutive layers.

Place the granular material as specified in the Contract Documents. Cover the geogrid with material within three calendar days after placement. Place, spread, and compact the granular material in a manner that prevents the development of wrinkles or movement of the geogrid. Keep the geogrid taut during the placement of the initial lift.

End dump granular material on the geogrid. Do not operate construction equipment directly on the geogrid. Place the end dumped material along the roadway centerline and spread outward to the roadway edges. Unless stated otherwise, maintain a minimum lift thickness of 12 inches for the lift

immediately above the geogrid. Do not turn equipment or brake suddenly on the first lift of material over the geogrid.

Fill in any ruts that form during construction by adding material. Do not cut down the fill between the ruts. If rut depths exceed 3 inches, reduce the size, weight, or both of the equipment. The Engineer may increase the lift thickness to obtain stability at the top of the lift. The Engineer may waive density requirements for the first lift if the subgrade is too soft to support compaction equipment.

Patch damaged geogrid. Place a geogrid patch that extends at least 3.0 feet beyond the damaged area in all directions. If the damaged portion is larger than 50 percent of the roll width, cut across the entire width of the roll to remove the damaged portion and overlap the cut ends. Replace or repair damaged geogrids at no expense to the Department.

204.08 Method of Measurement. The Department will measure Subgrade Compaction by the number of square yards computed from the profile grade and typical sections and actually compacted. The Department will measure 18 inches beyond the edge of the pavement surface, paved shoulders, and paved medians. The Department will measure the surface area of the paved driveways, paved mailbox turnouts, curb, and gutter.

The Department will measure Proof Rolling by the number of hours accepted. The Department will not measure idle time for repairs, servicing, loading and unloading ballast, adjusting tire pressure, bad weather, wet subgrade, usage at times and at locations other than Department directed, and stand-by time to be available when next needed or other cause for stand-by time.

The Department will measure Excavation of Subgrade; Embankment; Granular Embankment; and Granular Material, Type according to 203.09. All excavation is unclassified.

The Department will measure Geotextile Fabric by the number square yards of surface area of geotextile fabric placed. The Department will not include overlaps in the measurement.

The Department will measure the quantity of Geogrid by the number of square yards of subgrade covered by the geogrid. The Department will not include overlaps in the measurement.

204.09 Basis of Payment. The Department will pay according to 109.05 for changes or extra work that increases the haul distance more than a 1/2 mile to the work detailed in the Contract Documents. The Department will pay for additional quantities that increase the haul distance 1/2 mile or less at the unit bid price.

If unstable subgrade results from inadequate surface drainage or lack of maintenance, as required by 203.04.A, the Department will not pay for replacing the unstable subgrade and disposing of the removed material.

For problems identified in 204.06 that are the result of soils or conditions at lower elevations than the Contract work, the Department will pay for the corrections.

The Department will pay for the subgrade compaction in areas requiring excavation and replacement in 204.04, 204.05, and 204.07. The Department will not pay for subgrade compaction in areas stabilized under Item 206.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
204	Square Yard	Subgrade Compaction
204	Hour	Proof Rolling
204	Cubic Yard	Excavation of Subgrade
204	Cubic Yard	Embankment
204	Cubic Yard	Granular Embankment
204	Cubic Yard	Granular Material Type ___
204	Square Yard	Geotextile Fabric
204	Square Yard	Geogrid

ITEM 205 CHEMICALLY STABILIZED EMBANKMENT

205.01 Description. This work consists of constructing a chemically stabilized embankment by mixing cement or lime into the embankment soil using the method for the specified chemical.

The Contract Documents include an estimated quantity for the specified chemical.

205.02 Materials. Furnish materials conforming to:

Portland cement 701.04, 701.15
Lime (quick lime) 712.04.B

Furnish water conforming to 499.02. Furnish suitable natural soil, from on or off the project site, conforming to 703.16 and 203.03.

205.03 Submittals. Submit, for the Engineer's acceptance, a report that lists the type of equipment to be used, speed of the intended equipment usage, rate of application of the chemical, and calculations that demonstrate how the required percentage of chemical will be applied. Submit the report to the Engineer for acceptance at least 2 workdays before the stabilization work begins.

If the pay item for Mixture Design for Chemically Stabilized Soils is included in the Contract Documents, prepare and submit reports according to Supplement 1120.

205.04 Construction. Perform chemically stabilized embankment work when the air temperature is 40 °F or above and when the soil is not frozen.

Do not perform this work during wet or unsuitable weather.

Drain and maintain the work according to 203.04.A.

A. Spreading. If the pay item for Mixture Design for Chemically Stabilized Soils is not included in the Contract Documents, use the following spreading percentage rate for the specified chemical. The percentage is based on a dry density for soil of 115 pounds per cubic foot:

TABLE 205.04-1

Chemical	Spreading Rate
Cement	5 %
Lime	5 %

Spread the chemical uniformly on the surface using a mechanical spreader at the approved rate and at a constant slow rate of speed.

Use a distribution bar with a maximum height of 3 feet above the ground surface. Use a canvas shroud that surrounds the distribution bar and extends to the ground surface.

Minimize dusting when spreading the chemical. Control dust according to 107.19. Do not spread chemical when wind conditions create blowing dust that exceeds the limits in 107.19.

Do not spread the chemical on standing water.

B. Mixing. Immediately after spreading the chemical, mix the soil and chemical by using a power driven rotary type mixer. If necessary, add water to bring the mixed material to between 2 and 4 percent above optimum moisture content for cement, and to at least 3 percent above optimum moisture content for lime. Continue mixing until the chemical is thoroughly incorporated into the soil, all soil clods are reduced to a maximum size of 2 inches, and the mixture is a uniform color.

For areas not under pavements or paved shoulders, the Contractor may use a spring tooth or disk harrow in place of the power-driven rotary type mixer by modifying the above procedure as follows:

1. Open the soil with a spring tooth or disc harrow before spreading.

2. Spread the chemical.

3. Use a minimum disc harrow coverage of ten passes in one direction and ten passes in the perpendicular direction to thoroughly incorporate the chemical into the soil. Continue mixing until all soil clods are reduced to a maximum size of 1 inch and the mixture is a uniform color.

C. Compacting. Construct and compact chemically stabilized embankment according to 203.07, except use 98 percent of the maximum dry density for acceptance.

Determine the maximum dry density for acceptance using the Ohio Typical Moisture Density Curves, the moisture density curves from the Contractor's mixture design submittal, or the maximum dry density obtained by test section method.

205.05 Mixture Design for Chemically Stabilized Soils. When included in the plans, perform a mixture design for chemically stabilized soils according to Supplement 1120.

205.06 Method of Measurement. The Department will measure chemically stabilized embankment by the number of cubic yards used in the complete and accepted work, as determined by Item 203.

The Department will measure cement and lime by the number of tons incorporated in the complete and accepted work.

205.07 Basis of Payment. The Department will pay lump sum for all work, labor, and equipment described in 205.05. The Department will pay two-thirds of the lump sum amount bid when the sampling and testing is complete and the report is accepted by the Department. The Department will pay one-third of the lump sum amount bid when the chemically stabilized embankment is completed and accepted by the Department, and the field verification test results are all submitted.

The Department will not apply the quantity underrun adjustment factors in Table 104.02-2 to the bid unit prices for Cement and Lime.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
205	Cubic Yard	Cement Stabilized Embankment
205	Cubic Yard	Lime Stabilized Embankment
205	Ton	Cement
205	Ton	Lime
205	Lump Sum	Mixture Design for Chemically Stabilized Soils

ITEM 206 CHEMICALLY STABILIZED SUBGRADE

206.01 Description. This work consists of constructing a chemically stabilized subgrade by mixing cement or lime into the subgrade soil using the method for the specified chemical. The Contract Documents include an estimated quantity for the specified chemical.

206.02 Materials. Furnish materials conforming to:

Portland cement 701.04, 701.15
Lime (quick lime) 712.04.B

Furnish water conforming to 499.02.

For the curing coat, furnish rapid setting emulsified asphalt conforming to 702.04.

206.03 Submittals. Submit a report that lists the type of equipment to be used, speed of the intended equipment usage, rate of application of the chemical, and calculations that demonstrate how the required percentage of chemical will be applied. For phased work, list in the report the procedure to be used to construct the chemically stabilized subgrade to ensure full depth and continuity across phase interfaces. Submit the report to the Engineer at least 2 workdays before the stabilization work begins. Department acceptance of the report is not required. The absence of Department acceptance does not supersede the Engineer's authority as defined in 105.01.

If the pay item for Mixture Design for Chemically Stabilized Soils is included in the Contract Documents, prepare and submit reports according to Supplement 1120.

206.04 Test Rolling. When specified, test roll prior to chemical stabilization with a proof roller conforming to 204.06.

206.05 Construction. Perform chemical stabilization work (including the curing period) when the air temperature is 40 °F or above and when the soil is not frozen. Do not perform this work during wet or unsuitable weather.

Where phasing for maintenance of traffic uses part width stabilization of the subgrade, ensure that the required chemical spreading rate, mixing depth, and compaction are provided at the interface between adjacent phases.

A. Spreading. Shape the subgrade to the approximate profile grade prior to spreading the chemical so as to permit the construction of a uniformly compacted course of chemically treated soil to the thickness shown on the plans. The addition of the chemical will raise the subgrade profile approximately 1 inch. Remove this excess material during the fine grading.

If the pay item for Mixture Design for Chemically Stabilized Soils is not included in the Contract Documents, use the following spreading percentage rate for the specified chemical. The percentage is based on a dry density for soil of 115 pounds per cubic foot:

TABLE 206.05-1

Chemical	Spreading Rate
Cement	5 %
Lime	5 %

Spread the chemical uniformly on the subgrade using a mechanical spreader at the approved rate and at a constant slow rate of speed.

Use a distribution bar with a maximum height of 3 feet above the subgrade. Use a canvas shroud that surrounds the distribution bar and extends to the subgrade.

Minimize dusting when spreading the chemical. Control dust according to 107.19. Do not spread the chemical when wind conditions create blowing dust that exceeds the limits in 107.19.

Do not spread the chemical on standing water.

B. Mixing. Immediately after spreading the chemical, mix the soil and chemical as follows.

1. Cement. Mix the chemical and soil using a power driven transverse type mixer equipped with a computer controlled volumetric water readout. Continue mixing until the cement is thoroughly incorporated into the soil and is a uniform color.

Do not water during the initial mixing.

Perform the initial mixing so that 60 percent of the soil mixture passes the No. 4 sieve (4.75 mm) and 100 percent passes the 1 inch sieve (25mm), exclusive of aggregate larger than the No. 4 sieve (4.75 mm) size.

After the initial mixing, remix the soil and introduce water through the mixer to bring the mixed material to between 2 and 4 percent above optimum moisture. Uniformly distribute the water in sufficient quantity to hydrate the cement.

If the chemical and soil can be mixed to the required gradation and the water can be added to bring the soil mixture to the required moisture content in one mixing, then only one mixing of the soil, water and chemical is required.

Restrict the addition of water when the moisture content of the soil exceeds 3 percent above optimum moisture. Add water to the mixed soil within 2 hours after the initial mixing.

Once the water is added to the mixture, complete the mixing, compacting, and shaping within 2 hours from start to finish.

2. Lime. Mix the lime and soil using a power driven transverse type mixer equipped with a computer controlled volumetric water readout. If necessary, add water to bring the mixed material to at least 3 percent above optimum moisture content. Continue mixing until the lime is thoroughly incorporated into the soil, all soil clods are reduced to a maximum size of 2 inches, and the mixture is a uniform color.

After the initial mixing, lightly compact the material to seal it against rain or excessive drying by using a steel wheel or pneumatic tire roller.

Allow the lime and soil mixture to cure (mellow) for a period of not less than 24 hours and not more than 7 days. If more than 7 days elapse between initial mixing and final mixing, add an additional 0.5 percent of lime during the final mixing. Furnish the additional lime at no cost to the Department unless the delay beyond the 7-day limit is caused by conditions beyond the Contractor's control.

Perform the final mixing until the soil mixture is completely pulverized with all clods reduced to a maximum size of 1 inch and at least 60 percent of the clods passing the No. 4 (4.75 mm) sieve, exclusive of aggregate larger than the No. 4 sieve (4.75 mm). Continue mixing until the lime is uniformly distributed throughout the pulverized soil.

During final mixing, return the mixture to the moisture contents stated above, then shape and compact the mixture.

3. Mixture Depth Check. Check the uniformity of the mix by digging trenches or a series of holes at regular intervals for the full depth of treatment and inspecting the color and depth of the exposed material. Use diluted hydrochloric acid or phenolphthalein to indicate the presence of calcium and ensure that the chemical is mixed to the desired depth.

C. Compacting. Start compaction no more than 30 minutes after the final mixing.

Compact all chemically stabilized subgrade to the requirements in 204.03, except use 98 percent of the maximum dry density for acceptance. Determine the maximum dry density for acceptance by using the Ohio Typical Moisture Density Curves, the moisture density curves from the Contractor's mixture design submittal, or the maximum dry density obtained by test section method. Unless otherwise specified in the Contract Documents, the Engineer will perform all compaction tests according to Supplement 1015.

Use a vibratory footed roller weighing at least 10 tons.

Use the moisture controls according to 203.07.A, except ensure that the moisture content at time of compaction is at or above optimum.

Perform the final rolling using a smooth drum roller. Do not use vibration during the final rolling.

The Contractor may either shape and fine grade the chemically stabilized subgrade before the curing period, or shape the subgrade before the curing period and fine grade after the curing period. If fine grading before the curing period, fine grade the same day as mixing, compacting, and shaping. If fine grading after the curing period, shape the subgrade approximately 1 inch above the profile grade and typical sections. In either case, fine grade the subgrade to the profile grade and typical sections within the tolerances in 203.08.

D. Curing. By the end of each day's operation, cover the stabilized work area's surface with curing coat for curing the chemically stabilized subgrade. Use a rate of 1 gallon per 30 square feet for emulsions.

Apply the curing coat before the surface dries. If the surface starts to dry out, indicated by turning white, or the curing coat is delayed, apply water for temporary curing until the curing coat can be applied. Do not apply the curing coat unless the curing coat can set up before it rains. When the application of curing coat must be delayed, keep the chemically stabilized subgrade wet by using water until the curing coat can be applied.

Cure the chemically stabilized subgrade for at least five days before the placement of the overlying course.

E. Proof Rolling. After the curing period, proof roll the chemically stabilized subgrade according to Item 204.

F. Protection. Drain and maintain the work according to 203.04.A.

Do not operate any equipment on the chemically stabilized subgrade during the curing period.

Do not allow the chemically stabilized subgrade to freeze during the cure period.

Cover the completed chemically stabilized subgrade with the aggregate base within 60 calendar days.

206.06 Mixture Design for Chemically Stabilized Soils. When included in the plans, perform a mixture design for chemically stabilized soils according to Supplement 1120.

206.07 Method of Measurement. The Department will measure chemically stabilized subgrade by the number of square yards computed from the profile grade and typical sections accepted in place.

The Department will measure cement and lime by the number of tons incorporated in the complete and accepted work.

The Department will measure Test Rolling according to 204.08 as specified for Proof Rolling.

The Department will measure Curing Coat by the number of square yards computed from the profile grade and typical sections accepted in place.

206.08 Basis of Payment. The Department will pay lump sum for all work, labor, and equipment described in 206.06. The Department will pay two-thirds of the lump sum amount bid when the soil sampling and testing is complete and the report is accepted by the Department. The Department will pay one-third of the lump sum amount bid when the chemically stabilized subgrade is completed and accepted by the Department, and the field verification test results are all submitted.

The Department will not apply the quantity underrun adjustment factors in Table 104.02-2 to the bid unit prices for Cement and Lime.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
206	Square Yard	Cement Stabilized Subgrade, __ inches deep
206	Square Yard	Lime Stabilized Subgrade, __ inches deep
206	Ton	Cement
206	Ton	Lime
206	Square Yard	Curing Coat
206	Hour	Test Rolling
206	Lump Sum	Mixture Design for Chemically .Stabilized Soils

ITEM 208 ROCK BLASTING

208.01 Description. This work consists of using production and controlled blasting techniques to fracture rock or shale and to construct stable final rock cut faces.

Controlled blasting refers to the controlled use of explosives and blasting accessories in carefully spaced and aligned drill holes to produce a free surface or shear plane in the rock along the specified excavation backslopes. Controlled blasting techniques include presplitting, cushion blasting, and sliver cut blasting.

If the designed cut slope is steeper than 1:1 and deeper than 5 feet, use controlled blasting techniques, even if the main excavation is ripped or excavated. In rare instances, the Department will specify presplitting for 1 to 1 slopes. For all slopes that do not require controlled blasting techniques, rake, excavate, hoe ram, or mechanically shape these slopes to obtain a neat and smooth appearance.

Production blasting refers to the rock fragmentation blasts resulting from more widely spaced production holes drilled throughout the main excavation area adjacent to the controlled blast line. Detonate production holes in a controlled delay sequence.

208.02 Regulations on the Use of Explosives. Perform all blasting operations according to all applicable Federal, State, and local laws and regulations, and the provisions of 107.09. These regulated blasting operations include but are not limited to the following:

A. Storage and handling of explosives, blasting agents, and detonators.

B. Use of explosives in character and amount as allowed.

C. Storage plan, including the type of magazine or explosive storage facility to be used on the job site.

D. Record keeping, placarding, safe distances, and all other requirements concerning storage.

E. Obtaining and displaying magazine permits.

208.03 Product Specifications. Be aware that delay elements in blasting caps may deteriorate with age. Aged explosives are known to deliver much less than the rated energy.

If evaporation occurs or if improperly mixed, bulk explosives (such as ammonium nitrate and fuel oil) may not contain the proper amount of diesel oil. Low diesel oil drastically reduces the energy content of the explosive and commonly produces reddish brown or yellow fumes upon detonation even in dry blast holes.

Use products conforming to manufacturers' specifications. Ship the manufacturer recommended expiration dates with the products delivered to the project. Do not use any blasting product that is either excessively old or in a deteriorated condition. Cease all work until the product's age or quality is determined.

208.04 Stabilization. Remove or stabilize rock along the cut face that is loose, hanging, or creates a potentially dangerous situation during or upon the completion of the excavation in each lift. Do not drill the next lift until this work is performed.

208.05 Blasting Plan Submittal. Submit three copies of the Blasting Plan to the Engineer and one copy of the Blasting Plan to the Office of Construction Administration for review at least two weeks before beginning drilling and blasting operations, or at any time the drilling and blasting methods change. If the drilling and blasting methods change, submit four copies of the changed sections one week prior to the work.

The Blasting Plan shall include, at a minimum, the following:

A. General details of the drilling and blasting patterns and controls proposed to use for both the controlled and production blasting.

B. Station limits of proposed shots. Critical distances to structures. Place the pre-blast survey limits detailed in 208.14 on the Right-of-Way or plan view sheets.

C. One plan and section view for each main excavation cut showing the proposed typical range of drill patterns including a range of values for the free face, burden, blast hole spacing, blast hole diameters, blast hole angles, lift heights, and subdrill depths.

D. A typical loading diagram showing the type and amount of explosives, primers, and initiators and location and depth of stemming.

E. Typical range of initiator sequence of blast holes including delay times and delay system.

F. Manufacturers' data sheets for all explosives, primers, and initiators to be employed.

G. Use the blaster's plan form or the blasting plan forms in FHWA Publication FHWA-HI-92-001 *Rock Blasting and Overbreak Control*. Adapt these forms to meet the project requirements.

In a subsequent submittal, submit one Detailed Plan for all test sections. (Submit or fax at least 24 hours before the shot.) Detail the specific proposed amounts of materials and work described in 208.05.A through 208.05.G above on this Detailed Plan.

The Blasting Plan submittal is for quality control, informational, and record keeping purposes. The review of the Blasting Plan does not relieve the Contractor of the responsibility for using existing drilling and blasting technology and for obtaining the required results.

If specified in the Contract, use an approved blasting consultant, conforming to 208.13, to assist with the blast design and to ensure that the Blasting Plan is carried out on the project.

208.06 Production Holes. Perform all production blasting, including blasting carried out in conjunction with the blasting test section requirements of 208.07, according to the following requirements:

A. Drill the production blast holes on the patterns and to the depths submitted in the Blasting Plan and Detailed Plan, as specified in 208.05, but not exceeding a depth of 60 feet. Drill the production blast holes within two blast hole diameters of the staked collar location. If the blaster does not drill the production holes then the blaster shall inspect the holes and review the drilling logs prior to loading the holes.

B. Deepen or clean-out blast holes if they are plugged or unable to be fully loaded. Check and measure blast holes before any explosives are loaded into any of the holes to eliminate any safety hazard resulting from drilling near loaded holes.

C. Maintain a burden distance that is equal to or less than the bench height in order to control the blasting effects.

D. Drill the row of production blast holes immediately adjacent to the controlled blast line on a plane approximately parallel to the controlled blast line. Drill the production blast holes no closer than 6 feet to the controlled blast line. Drill the bottom of the production holes no lower than the bottom of the controlled blast holes except by the amount of subdrilling used in the production holes. Do not exceed 6 3/4 inches in diameter for the production blast holes. Delay the detonation sequence of the production holes toward a free face.

E. Maintain a stemming depth of at least 0.7 times the burden distance. If water is present or when blasting within 200 feet of a structure, use crushed No. 8 coarse aggregate for holes less than 4 inches in diameter and crushed No. 57 coarse aggregate for holes 4 inches in diameter and larger for the stemming material. Use the coarse aggregate gradations of Nos. 8 and 57 gradations on Table 703.01-1. If gravel is used, use crushed material with a minimum of two mechanically fractured faces on 60 percent of the material. In other locations, the Contractor may use drill cuttings for stemming, if it does not compromise the shot integrity.

F. Take all necessary precautions in the production blasting to minimize blast damage to the rock backslope.

G. Drill a line of buffer holes on a parallel plane adjacent to the presplit holes if presplit results are not satisfactory and production holes are damaging the presplit line. Drill the buffer hole 3 ± 1 inch in diameter. Drill the line of buffer holes approximately 3 feet from the presplit line, and space 3 to 5 feet center-to-center. Do not load the buffer holes with more than 50 percent of the full explosive load that could be placed in a 3-inch production hole. Delay the detonation sequence toward a free face.

208.07 Blasting Test Sections. Before commencing full-scale blasting operations, demonstrate the adequacy of the proposed Blasting Plan. Drill, blast, and excavate short test sections to determine which combination of methods, hole spacing, and charge works best. Use a test section with lengths up to 150 feet for presplitting and 120 feet for production blasting when field conditions warrant.

Do not exceed a production hole depth of 30 feet for the first test section.

Begin the controlled blasting tests for presplitting with the controlled blast holes spaced 36 inches apart, then adjust, if needed, until the spacing for full-scale presplit blasting operations is approved. A new test section is required to increase the spacing for the presplitting to a maximum of 48 inches.

Perform two test sections on every project. Use explosive depths greater than 20 feet for these test sections. Use one test section for controlled blasting and one test section for production blasting.

Apply the requirements specified for controlled and production blasting operations to the test section blasting.

For controlled blasting and for production blasts within 10 feet of the finished slope, do not drill ahead of the test shot area until the test section has been excavated and the results evaluated. If the test shots are unsatisfactory, revise methods as necessary to achieve the required results. Unsatisfactory test shot results include an excessive amount of fragmentation beyond the indicated lines and grade, excessive flyrock, or violation of other requirements within Item 208.

If the drilling and blasting methods do not produce the desired result of a uniform slope and shear face, within the tolerances specified, drill, blast, and excavate short sections, not exceeding 150 feet in length for a presplit line or 120 feet for a production hole line, until a technique produces the desired results.

The blasting consultant shall witness the test sections drilling and loading operations and be present when all test sections are shot. The time spent witnessing these operations is considered part of the time required to observe the loading, drilling, and blasting operations, as specified in 208.13.

208.08 Safety Procedures

A. Warnings and Signals. Establish a method of warning all employees on the job site of an impending blast.

Define the limits of the blasting area where there is a flyrock danger. Control the access to the blasting area to prevent the presence of livestock or unauthorized persons at least ten minutes before each blast.

Notify all employees in the area that a blast shall be fired with a one minute signal. After the blast is over, sound an "all clear" signal so all employees in the area understand that all blasting operations are finished.

One minute before the blast, sound three long signals, lasting five seconds, on an air horn or siren. For the all "clear" signal, sound one long signal, lasting at least five seconds, to indicate that all blasting has ceased.

Fill out the Department's Blast Site Security Plan Form (CA-EW-11).

B. Lightning Protection. Furnish, maintain, and operate lightning detection equipment during the entire period of blasting operations and during the periods that explosives are used at the site. If the lightning detection device indicates a blasting hazard potential, evacuate personnel from all areas where explosives are present. If a lightning detector indicates a blasting hazard, perform the following:

1. Clear the blasting area of all personnel.

2. Notify the Engineer of the potential hazards and precautions to be taken.

3. Terminate the loading of holes and return the unused explosives to the day storage area.

4. If blast holes are loaded and would pose a hazard to traffic if detonated, close the roads until the lightning hazard has passed.

5. When the hazard dissipates, inform the Engineer that production blasting can continue.

C. Check for Misfires. Observe the entire blast area for a minimum of five minutes following a blast to guard against rock fall before commencing work in the cut. The five minute delay between blasting and not allowing anyone but the blaster to enter the area is needed to make sure that no misfires have occurred.

During the five minute delay, the blaster is responsible for going into the shot area and checking all the holes to make sure that they have detonated. If any holes have not fired, the blaster shall handle these misfires before others enter the work area.

Halt the blasting operations if the methods being employed result in the required slopes not being in a stable condition or the safety and convenience of the traveling public is jeopardized.

D. Misfire Handling Procedures. If a visual inspection indicates that complete detonation of all charges did not take place, proceed as follows:

1. If the system was energized and no charges fired for electric systems, test the lead wire continuity before inspection of the remainder of the blast. For nonelectric systems, check the lead in or tube to make sure that detonation has entered the blast area.

2. If an inspection of the electrical trunkline or lead in tubing-line indicates that there is a break in the line or if the tubing did not fire, repair the system and refire the blast. If the inspection indicates that the trunkline has fired, and misfired charges remain, the blaster shall do the following:

a. Exclude all employees except those necessary to correct the problem.

b. Close traffic, if a premature explosion could be a hazard to traffic on nearby roads.

c. Correct the misfire in a safe manner. If the misfire poses a problem that the blaster cannot safely correct, the Contractor shall call a consultant or an explosive company representative skilled in the art of correcting misfires to correct the problem.

208.09 Presplitting. Perform all presplitting, including that carried out in conjunction with the blasting test section requirements of 208.07, according to the following requirements:

A. Completely remove all overburden soil and loose or decomposed rock along the top of the excavation for a distance of at least 30 feet beyond the end of the production hole drilling limits, or to the end of the cut, before drilling the presplitting holes.

B. Remove potentially dangerous boulders or other material located beyond the excavation limits.

C. Drill the presplit holes 3 ± 1 inch in diameter.

D. Control the drilling operations by using proper equipment and technique to ensure that no hole deviates from the plane of the planned slope by more than 12 inches either parallel or normal to the slope.

E. Extend presplit holes a minimum of 30 feet beyond the limits of the production holes to be detonated, or to the end of the cut as applicable.

F. Drill the presplit holes for any individual lift to a vertical depth of less than or equal to 30 feet. Demonstrate that the blast can stay within the above tolerances and produce a uniform slope. If more than 5 percent of the presplit holes are misaligned in any one lift, reduce the depth of the lifts until the 12-inch alignment tolerance is met.

G. If a cut height requires more than one lift or if there is a slope change (for example, when changing from a 1:1 slope to a 0.75:1 slope), use a maximum 2-foot offset between lifts for drill equipment clearances. Begin the presplit blast hole drilling at a point that allows for the necessary offsets and adjust to compensate for any drift that may occur in the upper lifts. Move the controlled blast line back if required to accommodate for these conditions.

H. The Contractor may drill 2 feet below ditch bottom to remove the toe berm.

I. Before placing charges, determine if the hole is free of obstructions for its entire depth. Exercise all necessary precautions so that the placing of the charges will not cause caving of material from the walls of the holes.

J. Drill hole conditions may vary from dry to filled with water. Use whatever types of explosives and blasting accessories necessary to accomplish the specified results.

K. Use a maximum diameter of explosives that is not greater than one-half the diameter of the presplit hole.

L. Do not use bulk ammonium nitrate and fuel oil (ANFO) in the presplit holes.

M. Use only standard explosives manufactured especially for presplitting in the presplit holes.

N. If using a continuous column cartridge type of explosives with detonating cord, assemble and affix the detonating cord according to the explosive manufacturer's instructions. Furnish a copy of the instructions to the Engineer.

O. The Contractor may make the bottom charge of a presplit hole larger than the line charges but not large enough to cause overbreak. Place the top charge of the presplitting far enough below the collar, and reduce the charge sufficiently, to avoid overbreaking and heaving.

P. Stem the upper portion of all presplit holes, from the topmost charge to the hole collar. Use stemming material conforming to the stemming specified for the production holes in 208.06.

Q. As long as equally satisfactory presplit slopes are obtained, either presplit the slope face before drilling for production blasting or presplit the slope face and production blast at the same time, provided the presplitting drill holes are fired first. If required to reduce ground vibrations or noise, delay the presplit holes, except that the hole-to-hole delay must be less than 25 milliseconds.

R. Do not deviate the presplit slope face more than 1 foot from a plane passing through adjacent drill holes, except where the character of the rock is such that irregularities are unavoidable. Measure the 1-foot tolerance perpendicular to the plane of the slope. Do not encroach on the roadbed with any portion of the slope.

S. Use the same diameter and drilled in the same plane and to the same tolerance as the presplit holes when using unloaded and unstemmed guide holes between presplit holes.

T. Detonate the presplit line before detonating any production holes, except when the closest horizontal distance between the production line and presplit line is greater than 50 feet.

208.10 Cushion Blasting. If the horizontal distance from the cut face to the existing rock face is less than 15 feet, the Contractor may use cushion blasting instead of presplitting. Perform cushion blasting according to 208.09, except as follows:

A. Detonate along the cut face after the detonation of all production holes.

B. Between the trim line and the nearest production row, use a difference in delay time of 25 to 75 milliseconds.

208.11 Sliver Cuts. For sliver cuts, pioneering the top of cuts and preparing a working platform to begin the controlled blasting and drilling operations may require unusual working methods and use of equipment. Use angle drilled holes or fan drilled holes during the initial pioneering operations to obtain the desired rock

face. Apply the hole diameter requirements for controlled blasting for pioneering work. Do not exceed a hole spacing of 36 inches.

208.12 Blaster. Use an experienced blaster in charge of all blasting operations. Use a blaster with at least five years of proven experience in heavy construction or highway rock blasting and with a sufficient amount of proven experience of the type of highway rock blasting required by the Contract.

Before or at the preconstruction conference, submit a resume of the credentials of the proposed blaster. Include in the resume a list of at least five heavy construction or highway rock blasting projects on which the blaster was responsibly in charge of the rock blasting. List a description of the projects, with details of the blasting operations. List the names and telephone numbers of project owners with sufficient knowledge of the projects to verify the submitted information. Obtain approval of the blaster before beginning any drilling and blasting work. Allow 30 days for the review of this documentation. The blaster shall perform the following:

A. Control the ground vibrations by the use of properly designed delay sequences and by using allowable charge weights per delay.

B. Base the allowable charge weights per delay on vibration levels that will not cause damage.

C. Establish the allowable charge weights per delay by carrying out trial blasts and measuring the vibration levels.

D. Independently measure the vibrations and airblast at the closest structure using the criteria and limits set in 208.15 and 208.16. Ensure that only trained and certified personnel set up the seismographs.

E. Use appropriate blast hole patterns, detonation systems, and stemming to prevent venting of blasts and to minimize airblast and noise levels produced by the blasting operations.

F. Carry out the trial blasts according to the blasting test section requirements of 208.07.

G. Report the vibrations (velocity and frequency) and airblasts on both seismographs before the next blast. This report shall denote whether or not these numbers exceeded the allowable set by the vibration specialist.

H. Modify 208.12.A through 208.12.F above as required to limit ground vibrations and airblast to the levels established by the vibration specialist, and the airblast and noise control specialist.

I. Coordinate and review the blast hole layout and drilling operations.

The blaster, blasting contractor, or the Contractor shall obtain insurance as specified in 107.12. Present a certificate of insurance 10 days before the blasting operations begin.

208.13 Blasting Consultant. If specified in the Contract, retain an experienced and recognized blasting consultant to assist in the blast design. The blasting consultant shall assist in the design of both the controlled and production blasting.

Retain a blasting consultant with at least five years of proven experience in heavy construction or highway rock blasting design and with a sufficient amount of proven experience of the type of highway rock blasting design required by the Contract. The Contractor shall not use a blasting consultant that is an employee of the Contractor, explosives manufacturer, or explosives distributor.

Before or at the preconstruction conference, submit a resume of the credentials of the proposed blasting consultant. Include in the resume a list of at least five heavy construction or highway rock blasting projects on which the blasting consultant was responsibly in charge of the rock blasting design. List a description of the projects, with details of the blast plans and modifications made during the project. List the names and telephone numbers of project owners with sufficient knowledge of the projects to verify the submitted information. Obtain approval of the blasting consultant before beginning any drilling and blasting work. Allow 30 days for the review of this documentation.

The blasting consultant shall observe the loading, drilling, or blasting operations for at least 8 hours per week if these operations are in progress for 40 or more hours per week. The blasting consultant shall witness the drilling, loading and blasting of the first shot in each major cut. At a minimum, the blasting consultant shall witness the drilling, loading and blasting of every 20th shot on the project. The blasting consultant shall write a written report to the Engineer at least once a month detailing the blasting operations. The time spent writing this report is not considered part of the time required to observe the loading, drilling, and blasting operations. The Contractor shall coordinate the blasting consultant's hours with the Engineer.

208.14 Pre-Blast Condition Survey. If specified in the Contract, conduct a pre-blast survey of any buildings, structures, or utilities within 1500 feet or to the nearest structure up to a 1/2-mile radius of the blasting operations. Use a greater radius if the structures are potentially at risk from blasting damage. The Contractor shall use a survey method acceptable to its insurance company. The Contractor is responsible for any damage resulting from blasting.

If owners or occupants fail to allow access to the property for the pre-blast survey, send a certified letter to the owner or occupant. Make the notification effort and the certified letter part of the pre-blast survey records.

Submit a copy of the pre-blast survey records to the Engineer before beginning the blasting operations at the critical blasting locations.

Notify occupants of local buildings before the commencement of blasting.

208.15 Vibration Control and Monitoring. If specified in the Contract, use vibration control and monitoring if blasting near buildings, structures, or utilities that may be subject to damage from blast induced ground vibrations. The vibration specialist interprets the seismograph records to ensure that the seismograph data is effective in the control of the blasting operations with respect to the existing structures.

Retain an experienced vibration specialist to establish the safe vibration limits. Use a vibration specialist with at least five years of proven experience in monitoring vibrations on heavy construction or highway rock blasting projects and with a

sufficient amount of proven experience of the type of highway rock blasting vibration monitoring required by the Contract.

Use a vibration specialist that is an expert in the interpretation of the vibration data. The Contractor shall not use a vibration specialist that is an employee of the Contractor, explosives manufacturer, or explosives distributor.

Before or at the preconstruction conference, submit a resume of the credentials of the proposed vibration specialist. Include in the resume a list of at least five heavy construction or highway rock blasting projects on which the vibration specialist was responsibly in charge of monitoring the rock blasting vibrations. List a description of the projects, with details of the vibration interpretations made on the project. List the names and telephone numbers of project owners with sufficient knowledge of the projects to verify the submitted information. Obtain approval of the vibration specialist before beginning any drilling and blasting work. Allow 30 days for the review of this documentation.

The vibration specialist shall perform the following:

A. Monitor each blast with an approved seismograph located between the blast area and the closest structure subject to blast damage.

B. Use a seismograph capable of recording particle velocity for three mutually perpendicular components of vibration in the range generally found with controlled blasting.

C. Furnish the data recorded for each shot before the next blast and include the following:

1. Identification of instrument used.
2. Name of approved observer and interpreter.
3. Distance and direction of recording station from blast area.
4. Type of ground at recording station and material on which the instrument is sitting.

D. Ensure that the peak particle velocity of each component of the safe limits of the nearest structure subject to vibration damage is not exceeded.

E. The vibration specialist may elect to summarize and report this information monthly, when the blaster measures the vibration and airblast with its own seismograph and reports the measurements on the vibration specialist's seismographs.

F. Establish what vibration limits are being used and explain why they are being used to the Engineer before blasting begins near structures denoted in the pre-blast survey in 208.14.

G. Stop all operations if the vibration limits are exceeded until the vibration specialist reports to the Engineer that no damage has occurred or will occur and that corrective action has been taken to lower the vibration.

208.16 Airblast and Noise Control. If specified in the Contract, install an airblast monitoring system between the main blasting area and the nearest structure subject to blast damage or annoyance.

Retain an experienced airblast and noise control specialist. Use an airblast and noise control specialist with at least five years of proven experience in airblast and noise control on heavy construction highway rock blasting projects and with a sufficient amount of proven experience of the type of rock blasting airblast and noise control monitoring required by the Contract. Use an airblast and noise control specialist that is an expert in airblast and noise control. The Contractor shall not use an airblast and noise control specialist that is an employee of the Contractor, explosives manufacturer, or explosives distributor.

Before or at the preconstruction conference, submit a resume of the credentials of the proposed airblast and noise control specialist. Include in the resume a list of at least five heavy construction or highway rock blasting projects on which the airblast and noise control specialist was responsibly in charge of the airblast and noise control of the rock blasting operations. List a description of the projects, with details of the airblast and noise control monitoring made on the project. List the names and telephone numbers of project owners with sufficient knowledge of the projects to verify the submitted information. Obtain approval of the airblast and noise control specialist before beginning any drilling and blasting work. Allow 30 days for the review of this documentation.

The airblast and noise control specialist shall perform the following:

A. Use equipment of the type specifically manufactured for the purpose to make the airblast measurements. Hold peak overpressure below 134 dB at the nearest structure or other designated location. Lower the overpressure limit if it proves too high based on damage or complaints.

B. The airblast and noise control specialist may establish the peak overpressure limits higher than 134 dB. Submit information explaining why higher limits are needed and are safe to the Engineer before blasting begins near structures denoted in the pre-blast survey in 208.14.

C. Furnish a permanent signed and dated record of the peak overpressure measurements to the Engineer immediately after each shot or use the same reporting procedures and time frames denoted for vibration in 208.15.

D. Stop all operations if the overpressure limits are exceeded until the airblast and noise control specialist reports to the Engineer that no damage has occurred or will occur and that corrective action has been taken to lower the airblast.

208.17 Hydrologist. If specified in the Contract, use a qualified hydrologist to monitor before, during, and after blasting or major excavation the quantity and quality of the water supplies within 1500 feet of the blasting or major excavation areas. The water supplies shall include, but not be limited to, all wells, springs, or other water supplies for human consumption.

Retain an experienced hydrologist. The Contractor shall not use a hydrologist that is an employee of the Contractor, explosives manufacturer, or explosives distributor.

Before or at the preconstruction conference, submit a resume of the credentials of the proposed hydrologist. Include in the resume a list of at least five heavy construction or highway projects on which the hydrologist was responsibly in charge of monitoring water quality and quantities. List a description of the projects, with details of the water monitoring or modeling performed on the projects. List the names and telephone numbers of project owners with sufficient knowledge of the projects to verify the submitted information. Obtain approval of the hydrologist before beginning any major excavation, drilling, or blasting work. Allow 30 days for the review of this documentation.

The hydrologist shall perform, at minimum, all of the following:

A. Review the available public records, including Ohio DNR well logs, to obtain background information and to identify the locations and geology of water supplies within 1500 feet of the blasting areas or major excavations.

B. Examine private wells, and public and industrial water supplies (as allowed by property owners or occupants), and measure water levels and well depths with a water level meter. Clean the water level meter before and between each use.

C. Collect water quality data (pH, e-coli, specific conductivity, turbidity, sulfate, and iron) from private wells, and public and industrial water supplies to determine the major excavation work or blasting effects on the water supplies by using field instruments.

D. Measure the water quality and water level for a minimum of two times per week for two weeks before, during, and two weeks after major excavation or blasting within 1500 feet of the water supplies.

E. Perform an associated field survey of the locations and elevations of wells and springs.

F. Evaluate the need for piezometers to monitor the ground water conditions. Place and monitor the piezometers as necessary.

G. Provide a monitoring plan report detailing the proposed activities, frequencies, testing, and any recommendations for monitoring the water supplies as detailed in 208.17.A through 208.17.F above. Submit this report at least 10 days before beginning the scheduled blasting or major excavation.

H. Provide a monthly report of the conclusions and results of the monitoring plan.

I. Provide a final report on the final condition or effect of the blasting or major excavation on the water supplies. Submit this report within 30 days after the blasting or major excavation is completed on the project.

J. Meet with the Engineer in order to coordinate this work and provide input, update the project schedule, report progress (including completed work and updated schedule), and make recommendations. Allow for ten meetings.

The Contractor is not responsible for damages to the above denoted water supplies if the blasting or excavation is done according to this specification. The Contractor is responsible for damage caused by negligence, vibration or noise above the allowable limits, flyrock, or back break.

208.18 Flyrock Control. Before firing any blast in areas where flying rock may result in personal injury or unacceptable damage to property or the work, cover the rock with blasting mats, soil, or other equally serviceable material to prevent flyrock.

If flyrock leaves the construction site or lands on a traveled road, the Contractor shall cease all blasting operations until the blasting consultant specified in 208.13 reviews the site and determines the cause and solution to the flyrock problem. Before blasting proceeds, submit a written report addressing the following:

A. Why the flyrock left the construction site or landed on a traveled road.

B. What corrective measures were taken to prevent this from reoccurring?

208.19 Public Meetings. If a blasting consultant, vibration specialist, airblast and noise control specialist, or hydrologist are specified in the Contract, make the consultant, specialists, Contractor's superintendent and blaster available for one day to prepare for and participate in a public meeting organized by the Engineer and conducted by the Contractor to inform the public about anticipated drilling and blasting operations. The consultant and specialists shall be prepared to answer any questions dealing with the magnitude of seismic motion, vibrations, airblast overpressure, flyrock, and water problems that may affect the public.

208.20 Record Keeping.

A. Daily Explosive Material Consumption. Keep a daily record of the transactions at each storage magazine. Update inventory records at the close of every business day. Show on the records the class and quantities received and issued and total remaining on hand at the end of each day. Check the remaining explosive inventory each day and report any discrepancies that would indicate a theft or loss of explosive material.

B. Report of Loss. If a loss or theft of explosives occur, report all circumstances and details of the loss or theft immediately to the nearest Bureau of Alcohol, Tobacco and Firearms, as well as to the local law enforcement authorities and the Engineer.

C. Daily Drilling and Blasting Logs. On a weekly basis, provide a daily log of the drilling and blasting operations. Update the log at the close of each business day.

Fill out the Department or blaster's drilling form to document the following: burden, spacing, bench height, hole depth and diameter, and subdrill depth. Document additional information about the drilling such as voids, mud seams, air pressure loss and lack of cuttings. The driller shall give this form to the blaster and the Department.

Document on the blasting log the number of blasts, times and dates of blasts, the blasting locations and patterns, and all of the following information:

1. Station limits of the shot.

2. Plan and section views of drill pattern including free face, burden, blast hole spacing, blast hole diameters, blast hole angles, lift height, and subdrill depth.

3. Loading diagram showing type and amount of explosive, primers, and initiators and location and depth of stemming.

4. Initiators sequence of blast holes including delay times and delay system in each blast hole.

5. Trade names and sizes of all explosives, primers, and initiators employed.

6. Signature of the blaster in charge.

7. Use the blaster's blasting form or the Blasting Report form in FHWA Publication FHWA-HI-92-001 *Rock Blasting and Overbreak Control*. Adapt these forms to meet the project requirements.

The drilling and blasting logs are for quality control, informational, and record keeping purposes. Review of the blast log by the Engineer does not relieve the Contractor of responsibility for the accuracy and adequacy of the drilling and blasting log.

D. Video Recording of Blasts. Record video of each blast. Index the recordings in a manner that permits easy and correct identification of each blast. Submit copies of the blast recordings on a weekly basis. If submitting the video recordings as electronic data files, furnish them in a video format acceptable to the Engineer and capable of being viewed on the Department's computers.

208.21 Method of Measurement. The Department will measure Presplitting by the number of square yards along the slope face of the cut. The horizontal measurement will begin at the first hole and end at the last hole of the cut, and the vertical slope measurement will be along the sloped drill hole.

208.22 Basis of Payment. The Department will not make separate payment for the production blasting operations. Payment for the production blasting is incidental to the other work items in the Contract requiring blasting. The Department will pay for additional excavation volume resulting from the 2-foot offsets at the Contract unit price for Item 203 Excavation. The Department will pay for the removal of this material beyond the excavation limits under 109.05.

The Department will pay lump sum for all work for the Pre-Blast Condition Survey, Blasting Consultant, Airblast and Noise Control, Vibration Control and Monitoring, and Hydrologist. The same person or consultant may perform the pre-blast survey, vibration control and monitoring, airblast and noise control, and the work required of the hydrologists. The Department may make intermediate payments based on the percentage of the work completed for Pre-Blast Condition Survey, Blasting Consultant, Airblast and Noise Control, Vibration Control and Monitoring, or Hydrologist.

Payment for guide holes is incidental to Presplitting. Payment for all of controlled blasting is included in the payment for Presplitting.

The Department will pay for stabilization under 109.05 if caused by geology. The Department will not pay for stabilization if caused by the Contractor's blasting operations.

The Department will pay for the placement and monitoring of piezometers according to 109.05.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
208	Square Yard	Presplitting
208	Lump Sum	Pre-Blast Condition Survey
208	Lump Sum	Blasting Consultant
208	Lump Sum	Airblast and Noise Control
208	Lump Sum	Vibration Control and Monitoring
208	Lump Sum	Hydrologist

ITEM 209 LINEAR GRADING

209.01 Description. This work consists of performing linear grading within the specified alignment detailed in the Contract Documents and within the grading tolerances.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

209.02 Materials. Furnish suitable materials as defined in 203.02.R.

209.03 Construction Requirements. Construct embankment and subgrade work according to Items 203 and 204.

When off-project-limit embankment material is needed for the work, an estimated quantity for Item 209 Borrow will be specified in the Contract Documents.

209.04 Ditch Cleanout. Reestablish the cross-section of the existing ditch. Use the required embankment material to fill the eroded conditions. The compaction requirements specified in Item 203 do not apply.

209.05 Reshaping Under Guardrail. Reshape graded shoulders at locations where the existing guardrail is removed or where the new guardrail is to be erected to ensure a smooth drainable surface free of all irregularities.

209.06 Preparing Subgrade for Shoulder Paving. Prepare the subgrade for shoulder paving by excavating the existing shoulder material to the depth shown in the plan. Trim unsound or broken edges of asphalt concrete or concrete pavement to a line established by the Engineer. Remove any unstable material and shape and compact the subgrade.

Compact the subgrade according to 204.03. Backfill areas graded in excess of the depth shown on the plans with Item 617 compacted aggregate at no expense to the Department.

When preparing the subgrade for a safety edge, grade an area approximately 10 inches wide from the edge of the paved surface to remove vegetation and any high spots. Provide a surface free of vegetation and level with or slightly below the surface to be paved.

209.07 Grading Tolerances. Do not encroach on stream channels, impact wetlands, or extend beyond construction limits, Right-of-Way or easement limits. Do not make alignment or profile grade adjustments that adversely affect drainage. Construct the work to the tolerances in 203.08.

209.08 Method of Measurement. The Department will measure Linear Grading, Reshaping Under Guardrail, and Preparing Subgrade for Shoulder Paving by the number of either stations or miles completed and accepted, along each side of the pavement. The Department will not make deductions for intersections and other gaps.

The Department will measure Ditch Cleanout by the number of feet measured along the centerline of the ditch.

The Department will measure Borrow according to 203.09.

209.09 Basis of Payment. The Department will pay according to 109.05 for changes or extra work that increases the haul distance by more than 1/2 mile to the work detailed in the Contract Documents. The Department will pay for additional quantities that increase the haul distance 1/2 mile or less at the unit bid price.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
209	Station or Mile	Linear Grading
209	Feet (Meters)	Ditch Cleanout
209	Station or Mile	Reshaping Under Guardrail
209	Station or Mile	Preparing Subgrade for Shoulder Paving
209	Cubic Yard or Ton	Borrow

250 PAVEMENT REPAIRS

ITEM 251 PARTIAL DEPTH PAVEMENT REPAIR

251.01 Description. This work consists of partial depth removal of existing pavement in areas exhibiting deterioration at the surface, applying tack coat, and placing and compacting asphalt concrete.

251.02 Removal of Existing Pavement. The Engineer will designate the location and limits of areas to be repaired. Provide the Engineer with aerosol spray paint to outline those areas for repair. Construct rectangular repair areas with dimensions as required to envelop surface deterioration. Unless otherwise specified, extend repair areas the full width of a traffic lane. Remove pavement to the depth shown on the plans.

Remove the pavement to the specified depth within the designated limits without loosening or otherwise damaging adjacent pavement. Dispose of removed pavement according to 202.

Trim the limits of the repair to form a vertical face 1.5 inches (38 mm) deep from the surface unless the repair is covered with an overlay within 60 days.

251.03 Placement of Asphalt Concrete. Apply 407.02 material to thoroughly coat the exposed surface and to fill cracks and joint openings.

Place and compact approved asphalt concrete meeting the design requirements of the item shown in the pay item description in one or more lifts as necessary to finish flush with the adjacent pavement surface. Place surface course mixes at a maximum 2 inch (50 mm) lift thickness and intermediate courses at a maximum 3 inch (75 mm) lift thickness.

Thoroughly compact the final lift using a Type I pneumatic tire roller conforming to 449.02. As the rolling progresses, add additional asphalt concrete, as necessary, to produce a smooth surface flush with the adjacent pavement surface.

Continuously compact each lift while the material is in a workable condition throughout the depth of the lift. Ensure that each lift is thoroughly compacted to a suitable density that will not result in displacement under traffic. If the Contract does not include resurfacing, seal the perimeter surface of the repaired area by applying a 2 to 4 inch (50 to 100 mm) wide strip of approved 705.04 material or 702.01 approved PG binder.

251.04 Method of Measurement. The Department will measure the quantity of Partial Depth Pavement Repair by the number of square yards (square meters) or cubic yards (cubic meters) of pavement repaired in the complete and accepted work, calculated using the dimensions established by the Engineer.

251.05 Basis of Payment. Payment is full compensation for furnishing all materials, including aerosol spray paint, tack coat, asphalt concrete, and perimeter seal.

The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
251	Square Yard (Square Meter)	Partial Depth Pavement Repair (441)
251	Square Yard (Square Meter)	Partial Depth Pavement Repair (442)
251	Cubic Yard (Cubic Meter)	Partial Depth Pavement Repair (441)
251	Cubic Yard (Cubic Meter)	Partial Depth Pavement Repair (442)

ITEM 252 FULL DEPTH RIGID PAVEMENT REMOVAL AND FLEXIBLE REPLACEMENT

252.01 Description. This work consists of the full depth removal of existing rigid pavement, correcting the subgrade, placing and compacting asphalt concrete, and restoring the shoulders.

252.02 Removal of Existing Rigid Pavement. Conform to 255.03, except the last paragraph does not apply.

252.03 Correction of Subgrade. Shape and recompact the subgrade as the Engineer directs. Clean all vertical faces of the existing pavement, and coat them with asphalt material according to 401.06.

252.04 Placement of Asphalt Concrete. Construct the pavement replacement by placing and compacting Item 301, 441 Type 2, or 442 19mm material in two or more lifts according to 449.03.

Thoroughly and uniformly compact all lifts before the final lift using suitable mechanical compaction equipment operated over the entire replacement area.

Thoroughly compact the final lift using a pneumatic tire roller conforming to 449.02. As the rolling progresses, add additional asphalt concrete, as necessary, to produce a smooth surface flush with the adjacent pavement surface.

Continuously compact each lift while the material is in a workable condition throughout the depth of the lift. Ensure that each lift is thoroughly compacted to a suitable density that will not result in displacement under traffic.

Trim the limits of the repair to form a vertical face 1.5 inches (38 mm) deep from the surface unless the repair is covered with an overlay within 60 days.

If the Contract does not include resurfacing, seal the perimeter surface of the repaired area by applying a 2 to 4 inch (50 to 100 mm) wide strip of approved 705.04 material or 702.01 approved PG binder.

After completing repairs, restore the shoulders to the condition that existed prior to the repair work.

252.05 Method of Measurement. The Department will measure the quantity of Full Depth Rigid Pavement Removal and Flexible Replacement by the number of square yards (square meters) of rigid pavement repaired in the complete and accepted work, calculated using the dimensions established by the Engineer.

The Department will measure the quantity of Full Depth Pavement Sawing by the number of feet (meters) of full depth saw cuts in the complete and accepted work. The Department will not measure offset saw cuts. The Department will not measure additional cuts made to facilitate the removal of the pavement

252.06 Basis of Payment. Payment is full compensation for furnishing all materials, including aerosol spray paint, removing pavement, correcting the subgrade, placing flexible pavement, sealing, and restoring the shoulders.

Include the cost of removal, disposal, and replacement of pavement damaged adjacent to the repair area in the contract unit price for Full Depth Rigid Pavement Removal and Flexible Replacement.

Include the cost of any additional concrete sawing and removal depths less than 1 inch (25 mm) greater than those shown in the plans.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
252	Square Yard (Square Meter)	Full Depth Rigid Pavement Removal and Flexible Replacement
252	Foot (Meter)	Full Depth Pavement Sawing

ITEM 253 PAVEMENT REPAIR

253.01 Description. This work consists of removing existing asphalt concrete, brick, portland cement concrete, or aggregate pavement courses; shaping and

compacting the exposed material; and placing new asphalt concrete pavement or aggregate and asphalt concrete pavement courses.

The plans show details about the repairs and replacement material.

253.02 Removal of Existing Pavement. The Engineer will designate the location and limits of areas to be repaired. Provide the Engineer with aerosol spray paint to outline those areas for repairs. Repair the full depth of the pavement, unless otherwise shown on the plans.

Cut the existing pavement at the limits specified and as necessary to prevent disturbing or undermining the remaining pavement during removal. Completely remove pavement in the repair area to the specified depth without displacing, undermining, or otherwise damaging the remaining pavement. Dispose of removed pavement according to 202.

Trim the limits of the repair to form a vertical face 1.5 inches (38 mm) deep from the surface unless the repair is covered with an overlay within 60 days.

253.03 Placement of Asphalt Concrete. Shape and compact the exposed underlying material as the Engineer directs. Before placing asphalt concrete, clean all vertical faces of the existing pavement and coat them with asphalt material according to 401.06. Place the replacement material in lifts as the Engineer directs. Thoroughly and uniformly compact each lift using suitable compaction equipment as the Engineer directs. Finish the final lift flush with the adjacent pavement surface.

Thoroughly compact the final lift using a pneumatic tire roller conforming to 449.02. As the rolling progresses, add additional asphalt concrete, as necessary, to produce a smooth surface flush with the adjacent pavement surface.

Continuously compact each lift while the material is in a workable condition throughout the depth of the lift. Ensure that each lift is thoroughly compacted to a suitable density that will not result in displacement under traffic.

If the Contract does not include resurfacing, seal the perimeter surface of the repaired area by applying a 2 to 4 inch (50 to 100 mm) wide strip of approved 705.04 material or 702.01 approved PG binder.

After completing repairs, restore the existing shoulders to the condition that existed prior to the repair work.

253.04 Method of Measurement. The Department will measure the quantity of Pavement Repair by either the number of square yards (square meters) or cubic yards (cubic meters) of pavement repaired in the complete and accepted work, calculated using the dimensions established by the Engineer.

253.05 Basis of Payment. Payment is full compensation for furnishing all materials, including aerosol spray paint and replacement and restoration materials; cutting, removing, and disposing of existing pavement; shaping and compacting the exposed underlying material; placing new pavement; and restoring the shoulders.

The Department will not pay for additional work to repair damage caused by the pavement sawing or pavement removal.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
253	Square Yard (Square Meter)	Pavement Repair
253	Cubic Yard (Cubic Meter)	Pavement Repair

ITEM 254 PAVEMENT PLANING

254.01 Description. This work consists of planing asphalt concrete and disposing of the cuttings, and, if specified in the Contract, patching the planed surface.

254.02 Equipment. Use self-propelled planing equipment that has sufficient power and stability to consistently and efficiently meet the requirements of 254.05 and the plans. Use equipment with either grinding, sawing, or milling type cutters. Ensure that the cutters are mounted rigidly to the carrier and are adjustable to control the depth of cut and cross-slope. Use equipment with a suitable carrier wheelbase or with an automatic control system having an external reference. Ensure that cross-slope adjustments or automatic controls are capable of producing either a variable or a constant cross-slope, as required.

For small or confined areas, the Contractor may use suitable supplemental equipment or methods approved by the Engineer.

254.03 Planing. Make one or more planing passes, as necessary, over the designated area to the depth specified in the plans. Remove irregularities such as bumps, corrugations, and wheel ruts, when required, to establish a new pavement surface elevation or cross-slope.

Remove cuttings from the surface following each pass. Before opening the completed area to traffic, thoroughly clean the surface of all loose material that would create a hazard or nuisance, or would redeposit into the surface texture. Dispose of cuttings according to 202.

Implement effective measures to control dust, pavement contamination, and the scattering of loose particles during planing and cleaning operations.

If planing damages the adjacent pavement, repair the damaged area to the Engineer's satisfaction. Ensure that the repaired area matches the adjacent pavement in terms of smoothness and mix type.

254.04 Surface Patching. Patch areas of the planed surface that the Engineer designates that have spalling or dislodged unsound pavement. Before patching,

clean areas of loose material, coat with 407.02 asphalt material, and fill with Item 441 Type 1 or 442 9.5mm or 12.5mm material. Level and compact new material flush to the adjacent planed pavement.

254.05 Surface Tolerances. Plane the surface free from grooves, ridges, gouges, or other irregularities detrimental to the safe operation of vehicles on the planed surface.

If the Contract specifies planing without resurfacing, plane the surface to a smoothness of 1/8 inch in 10 feet (3 mm in 3 m). If the Contract specifies resurfacing after planing, plane the surface to a smoothness of 1/4 inch in 10 feet (6 mm in 3 m). Match the surfaces at the edges of adjacent passes within 1/8 inch (3 mm). Ensure that the cross-slope of the planed surface is within 3/8 inch in 10 feet (10 mm in 3 m) of the specified cross-slope.

254.06 Method of Measurement. The Engineer will measure the quantity of Pavement Planing, Asphalt Concrete by the number of square yards (square meters).

The Engineer will measure the quantity of Patching Planed Surface by the number of square yards (square meters).

254.07 Basis of Payment. The Department will not pay for repairs due to damage caused by planing operations. If the depth of the planed surfaces is increased by more than 3/8 inches (10 mm) the Department will compensate for the additional work.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
254	Square Yard (Square Meter)	Pavement Planing, Asphalt Concrete
254	Square Yard (Square Meter)	Patching Planed Surface

ITEM 255 FULL DEPTH PAVEMENT REMOVAL AND RIGID REPLACEMENT

255.01 Description. This work consists of full depth removal of existing pavement; removing subbase where specified; compacting the subgrade; furnishing

and placing dowels, tiebars, and mesh where specified; placing, consolidating, finishing, and curing new portland cement concrete to the level of the adjacent portland cement concrete pavement; replacing wearing course where required; and restoring affected shoulders.

255.02 Materials. Furnish materials conforming to:

Concrete, Class QC 1, QC MS, QC FS	499
Curing materials, Type 2	705.07
Non-shrink non-metallic grout	705.20
Reinforcing steel	709.10
Preformed elastomeric joint sealer	705.11
Tiebar	705.01 or 709.00
Dowel bars and basket assemblies	705.01 or 709.13
Expansion shield anchors Type A	712.01

Use epoxy coated hook bolt, wiggle bolt, and coupling.

Select and furnish grout from the Qualified Product List issued by the Laboratory that firmly anchors the dowel or tiebar within 30 minutes.

Rapid Repair Concrete Mix Materials. If the bid item requires RRCM (Rapid Repair Concrete Mix) do not use the Concrete classes listed above. Develop a specialized mix design as follows:

Use one of the following special rapid early repair admixture systems such as:

4 x 4 concrete system

Rapid -1

Other manufactured systems acceptable to the Director

Develop a RRCM concrete mix design that will achieve a flexural strength of 400 psi (2.8 MPa) in not less than 4 hours and not more than 6 hours using 6 in x 6 in (150 mm x 150 mm) beam samples conforming to ASTM C293.

Use cements conforming to 701.02, 701.04 or 701.05

Use fine aggregate conforming to 703.02.A

Use coarse aggregate(s) conforming to 703.02.B and 703.13

Provide concrete with 4 to 8 percent air content.

During the testing of the RRCM mix design develop the mix's maturity curve according to Supplement 1098 using the actual materials that will be used on the project.

Document and submit to the Engineer the RRCM mix design results showing flexural strength, time to strength, materials, sources of materials, quantities of materials and batching requirements.

The Engineer will have 10 days review the mix design and accept or reject.

255.03 Removal of Existing Pavement. The Engineer will locate and mark all areas for repair before the start of diamond sawing. Provide the Engineer with aerosol spray paint to outline those areas for repair.

Saw cut the existing rigid pavement to the full depth at the limits of the area designated by the Engineer using a diamond saw blade. Where there is an existing asphalt concrete overlay on top of the concrete pavement to be removed, the Contractor may make either a full depth saw cut through the asphalt concrete overlay and the concrete pavement, or make an offset saw cut through the asphalt concrete overlay. If making an offset saw cut through the asphalt concrete overlay, remove the overlay as necessary to provide clearance for the full depth saw cut through the concrete pavement. The Contractor may elect to make additional cuts to facilitate the removal of the pavement.

Remove pavement in the repair area by the lift-out method without damaging or undermining the remaining pavement. After the repair area is isolated by full depth saw cuts, drill holes through the deteriorated slab, and install lift pins. Vertically lift the pavement out of the repair area. Remove loose debris left behind after lift-out using hand methods. Dispose of removed pavement according to Item 202.

Do not break the pavement and clean out the material using a backhoe unless the Engineer determines that the lift-out method is not feasible due to deteriorated pavement or existing asphalt concrete repairs.

If the bottom face of the adjacent concrete pavement is deteriorated for a height greater than one-fourth (1/4) the thickness of the rigid pavement, make additional full depth saw cuts as directed by the Engineer along the full width of the lane or lanes to remove the deteriorated areas. Repair pavement damaged during the pavement sawing or pavement removal according to Item 255 or Item 256.

255.04 Correction of Subgrade or Subbase. After removing the pavement full depth and before installing dowels or tiebars, shape and re-compact the subgrade or subbase to the satisfaction of the Engineer. Use concrete to replace any subgrade or subbase material removed as part of the rigid pavement replacement.

255.05 Placing Dowels and Tiebars. Drill dowel and tiebar holes using hydraulic, electric, or pneumatic percussion drills without spalling or damaging the existing concrete. Provide drills capable of independent adjustment of each drill shaft in the horizontal and vertical direction. When drilling dowels, use a device capable of drilling a minimum of three holes at a time. For patches 10 feet (3 m) or greater in length, provide tie bars or wiggle bolts of the size and spaced as shown on the standard construction drawings along the longitudinal joint(s). Blow all drilled holes clean with oil-free compressed air. Maintain holes dry and frost free before grouting the dowels or tiebars. Pneumatically inject grout starting at the rear of the drilled holes and drawing a bead of material towards the front. Inject a sufficient amount of grout to fill all voids around the dowels and tiebars. Use a grout retention disc with a radius slot as shown in the standard drawings to retain the grout within the drilled holes. Place the grout retention disc on the dowels and tiebars at the end to be inserted in the hole. Insert dowels and tiebars in the holes and rotate the dowels and tiebars approximately one full revolution. Ensure a small amount of grout extrudes through the radius slot in the grout retention disc when the dowels and tiebars are installed. Hold dowel bars in proper alignment until the grout has hardened.

255.06 Placement of Portland Cement Concrete. Do not place any portland cement concrete for rigid pavement replacement until the grout around the dowels and tiebars has hardened. Coat dowel bars with bond breaking material conforming to 451.09.B. Place portland cement concrete according to 451.07. Use forms when placing Portland cement concrete against asphalt concrete or any unbound material. Cast each patch in one continuous operation. Consolidate the concrete around the perimeter of the patch and within the limits of the patch area using an internal type vibrator. Use approved internal type vibrators capable of visibly affecting the concrete for a distance of 12 inches (0.3 m) from the vibrator head.

When using RRCM concrete install maturity sensors to measure the maturity of each day's placement according to Supplement 1098. If RRCM placement from one location to another is delayed by more than 1 hour treat the delayed placement as a new day's placement and install additional maturity sensors according to Supplement 1098.

Ensure that batch tickets of the delivered RRCM conform to the accepted mix design. Provide batch tickets in accordance with 499.07.

Screed repairs less than 12 feet (3.7 m) in length parallel to the centerline. Screed repairs 12 feet (3.7 m) in length and longer perpendicular to the centerline.

While the concrete is still in a plastic state, test the surface for trueness and for being flush with the edges of the adjacent slabs using a 10-foot (3 m) straightedge. Place the straightedge parallel to the pavement centerline with half of the straightedge resting on the adjacent pavement, and draw the straightedge across the patch to test the patch edges. Check areas within the patch length in a similar manner. Where the straightedge shows deviations, correct all high or low areas exceeding 1/8 inch in 10 feet (3 mm in 3 m). Recheck the concrete surface after making corrections to ensure conformance to the above tolerance. Make additional checks and corrections until patch is within tolerance.

Texture the new concrete surface like that of the surrounding pavement.

Apply the liquid membrane-forming curing compound at a minimum rate of 1 gallon (1 L) of material for each 150 square feet (3.7 m^2).

255.07 Wearing Course Replacement. Trim the limits of the repair to form a vertical face 1.5 inches (38 mm) deep from the surface. Replace the removed asphalt concrete overlay with material as shown on the plans. Compact the material as approved by the Engineer using any of the roller types specified in 401.13. Apply Item 407 tack coat to the replacement surfaces.

Before opening the rigid replacement to traffic, restore the shoulders to the original line and grade. Use either aggregate or asphalt concrete as shown on the plans or as the Engineer directs. Fill the low areas, and compact them flush with the surrounding shoulder.

Seal the perimeter surface of the repaired areas by applying a 2 to 4 inch (50 to 100 mm) wide strip of approved 705.04 material or 702.01 approved PG binder.

255.08 Opening to Traffic. Do not open the rigid replacement to traffic until the concrete attains a modulus of rupture of 400 pounds per square inch (2.8 MPa).

For RRCM mixes do not open the rigid replacement to traffic until the RRCM attains a modulus of rupture of 400 pounds per square inch (2.8 MPa) based on maturity testing.

If maintaining traffic in adjacent lanes, schedule work to place the concrete in the prepared repair area within 48 hours after removing pavement. In accordance with standard drawing MT-101.90, drums may be used as a separator to the adjacent traveled lane for repairs 60 feet (18 m) or less in length.

If unable to complete placement of the concrete in the exposed repair area by the end of a daily work shift, fill or cover repair areas less than 4 feet (1.2 m) from the traveled lane. Fill using a temporary patch material suitable to the Engineer or cover unfilled repair areas 10 feet (3 m) or less in length with a steel plate.

Do not leave repair areas unfilled with concrete when work is suspended on weekends or holidays. If unable to complete placement of the concrete in the exposed repair area before suspending work for a weekend or holiday or within the 48-hour time specified above, fill the repair area with an asphalt concrete mixture or other suitable temporary patch material with a durable surface as the Engineer directs. Maintain the temporary patches while they are in service.

255.09 Method of Measurement. The Department will measure the quantity of Full Depth Pavement Removal and Rigid Replacement by the number of square yards (square meters) repaired in the complete and accepted work.

The Department will measure the quantity of Full Depth Pavement Sawing by the number of feet (meters) of perimeter full depth saw cuts in the complete and accepted work. The Department will not measure offset saw cuts. The Department will not measure additional cuts made to facilitate the removal of the pavement.

255.10 Basis of Payment. Payment is full compensation for furnishing all materials, including paint; developing and testing the concrete mix, removing pavement by any method; removing subbase for undercut replacement; compacting subbase and subgrade; placing rigid pavement, including concrete necessary to replace removed subbase or subgrade; furnishing and placing dowels, tiebars, and mesh; performing maturity testing and acceptance; placing, maintaining, removing, and disposing of temporary patches, and restoring the shoulders.

The Department will not pay for additional concrete sawing and removal depths within 1 inch (25 mm) greater than those shown on the plans.

The Department will not pay for additional work to repair damage caused by pavement sawing, pavement drilling or pavement removal.

The Department will include tack coat in the cost of the asphalt concrete. The Department will pay for asphalt concrete according to Item 301, Item 441, or Item 442.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
255	Square Yard (Square Meter)	Full Depth Pavement Removal and Rigid Replacement, Class ___

255	Foot (Meter)	Full Depth Pavement Sawing

ITEM 256 BONDED PATCHING OF PORTLAND CEMENT CONCRETE PAVEMENT

256.01 Description. This work consists of bonded patching of portland cement concrete pavements at spall areas adjacent to cracks or joints or other areas of the pavement as designated by the Engineer. This work involves removing all loose and unsound concrete and asphalt material patches; removing sound concrete as directed; preparing the surface; applying a bonding grout if required; reconstructing the joint or crack; and mixing, placing, finishing, and curing of the patching material called out in the pay item description.

256.02 Materials. Furnish materials conforming to:

Portland cement	701.05
Fine aggregate	703.02
Coarse aggregate, No. 8 size	703.02
Curing material	705.07
Air-entraining admixture	705.10
Quick setting concrete mortar	705.21

256.03 Equipment. Use a milling machine, concrete saw, jackhammers, or other approved equipment to remove existing surface material. Provide oil and moisture free compressed air for cleaning and abrasive blasting the prepared area. Provide an on-site concrete mixer capable of mixing a minimum of 2-cubic foot (0.06 m^3) batches of patching material. Provide chipping hammers not heavier than the nominal 35-pound (16 kg) class.

256.04 Removal of Unsound Concrete. The Engineer will locate and mark all areas to be repaired prior to concrete sawing. Provide the Engineer with aerosol spray paint to outline the areas for repair. Repair areas will be rectangular or square in shape with dimensions as required to envelope the surface deterioration.

Saw the perimeter of all areas designated for removal to a depth of 1 inch (25 mm) to produce a vertical or slightly undercut face. Make additional saw cuts as required to facilitate removal. Remove all unsound concrete, all asphalt material, and all obviously loose and disintegrated concrete within the patch area. Remove

sound concrete where required to achieve the minimum depth within the patch area. Remove concrete by jack hammering or milling. The minimum depth of any partial depth repair is 1 1/2 inch (38 mm) except at the perimeter saw cuts. Operate chipping hammers at an angle of less than 45 degrees measured from the surface of the pavement. During removal of unsound concrete, remove all pavement reinforcing exposed in the patch areas using a cutting tool or a torch.

256.05 Preparation of Patch Area. Before placing the patching material or before applying the bonding grout, if used, abrasive blast the exposed concrete surfaces to which the patching material is to bond until free of loose particles, oil, dust, traces of asphalt concrete and joint sealer, and other contaminates. Do not begin abrasive blasting operations until implementing reasonably available engineering controls to limit fugitive dust that are acceptable to the Engineer. Conform to State, regional, and local government agency requirements regarding control of dust generated by the blasting operation. Remove all sandblasting residue with compressed air just prior to placing the patching material or just prior to applying the bonding grout, if used. For Types B and C patching materials that do not use water as the activator, perform additional surface preparation according to the patching material manufacturer's recommendations.

Recreate joints and cracks through or along the patch using a joint board that extends below the prepared surface and has a width equal to the existing joint or crack. One hour after placing the patching material, remove the joint board in a manner that does not damage the patch.

256.06 Bonding Grout Installation. For bonding Type A patches, use grout that consists of equal parts, by volume, of portland cement and sand, mixed with sufficient water to form a stiff slurry. Using a stiff brush or broom, apply a thin, uniform coating of grout to the prepared surface. Scrub the grout onto the dry surfaces of the prepared area to be patched immediately before placing the patching material. Do not allow excess grout to collect in low spots. Do not allow the grout to dry before placing the new concrete. Paint grout over all sawed joints between the patch and adjacent concrete immediately after completing the finishing.

For bonding Types B and C patches, conform to the patching material manufacturer's recommendations.

256.07 Placement of Patch Material. Use Type A, B, or C patch material as follows:

A. Type A. Provide patch material consisting of one part high early strength portland cement, one and a half parts fine aggregate, and one and a half parts coarse aggregate by volume. Add sufficient air-entraining admixture to maintain an air content of 8 ±2 percent. Add enough water to obtain the minimum slump practical for placing, and do not allow slump to exceed 4 inches (100 mm). Mix the materials on site. Do not use ready-mixed concrete. Place the concrete mixture in the patch area while the bonding grout is still wet. Slightly overfill, vibrate, and strike off the concrete.

B. Type B. Provide patch material consisting of quick setting concrete mortar 705.21, Type 1 or 2. Mix and place the mortar according to the manufacturer's recommendations. Add coarse aggregate, as needed, according to the

manufacturer's instructions. Place the concrete mixture in the patch area. If the manufacturer's requirements specify using bonding grout, place the concrete mixture while the bonding grout is still wet. Slightly overfill, vibrate, and strike off the concrete.

C. Type C. Provide patch material consisting of a blend of quick setting concrete mortar 705.21, Type 2 and selected aggregates with an activator. Mix and place these materials according to the manufacturer's recommendations. Add coarse aggregate, as needed, according to the manufacturer's instructions. Place the concrete mixture in the patch area. If the manufacturer's requirements specify using bonding grout, place the concrete mixture while the bonding grout is still wet. Slightly overfill, vibrate, and strike off the concrete.

Screed patches 12 feet (3.7 m) and less in length parallel to the centerline. Screed patches over 12 feet (3.7 m) in length perpendicular to the centerline.

While the concrete is still in a plastic state, test the surface for trueness and for being flush with the edges of the adjacent slabs using a 10-foot (3 m) straightedge. Place the straightedge parallel to the pavement centerline with the ends resting on the adjacent pavement and draw the straightedge across the patch. Where the straightedge shows deviations, correct all high or low areas exceeding 1/8 inch in 10 feet (3 mm in 3 m). Recheck the concrete surface after making corrections to assure that the patch area meets the surface tolerance before the patching material hardens.

Texture the new concrete surface similar to that of the surrounding pavement.

256.08 Curing and Opening to Traffic. Cure Type A patches according to 451.11, except allow the patch to attain a modulus of rupture of 400 pounds per square inch (2.8 MPa) before opening to traffic. Cure Types B and C patches according to the manufacturer's recommendations.

256.09 Method of Measurement. The Department will measure the quantity of Bonded Patching of Portland Cement Concrete Pavement, Type ___ by the number of square feet (square meters) of the exposed surface of all patches, irrespective of the depth of the patch, repaired in the complete and accepted work. If the actual measured area of a patch is less than 2 square feet (0.2 m²), the Engineer will increase each such measurement to 2 square feet (0.2 m²).

256.10 Basis of Payment. The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
256	Square Feet (Square Meter)	Bonded Patching of Portland Cement Concrete Pavement, Type ___

ITEM 257 DIAMOND GRINDING PORTLAND CEMENT CONCRETE PAVEMENT

257.01 Description
257.02 Equipment
257.03 Construction
257.04 Final Surface Finish

257.05 Method of Measurement
257.06 Basis of Payment

257.01 Description. This work consists of diamond grinding and texturing Portland cement concrete pavement longitudinally to substantially eliminate joint and crack faulting and to restore proper riding characteristics to the pavement surface.

257.02 Equipment. Provide grinding equipment that is a power driven, self-propelled machine that is specifically designed to smooth and texture Portland cement concrete pavement with diamond blades or diamond impregnated cylinder rings. Mount the blades or cylinder rings on an arbor head. Provide a grinding head at least 3 feet (0.9 m) wide. Ensure the equipment is capable of grinding the surface in the longitudinal direction without causing spalls or other damage at cracks, joints and other locations. Ensure the equipment is capable of correcting the pavement profile and providing proper cross slope on the concrete pavement.

Provide equipment with an effective wheelbase of at least 12.0 feet (3.6 m); a set of pivoting tandem bogey wheels at the front of the machine and rear wheels that travel and track in the fresh cut pavement. Ensure the center of the grinding head is no further than 3.0 feet (0.9 m) forward from the center of the back wheels. Ensure the equipment is of a shape and dimension that does not encroach on traffic movement outside of the work area.

Furnish and maintain a profiler conforming to Supplement 1058 for daily use during the grinding operations. Provide all necessary supplies to fully operate and graph the results of testing the ground pavement for smoothness. The Engineer will verify the profiler according to Supplement 1058.

257.03 Construction. The plans will designate the areas of pavement surfaces to be ground. Grinding of bridge decks, approach slabs, and roadway shoulders will not be required unless indicated on the plans or required to provide drainage. Perform grinding in a manner that eliminates crack or joint faults while providing positive lateral drainage by maintaining a constant cross-slope between grinding extremities in each lane. Transition auxiliary or ramp lane grinding as required from the mainline edge to provide positive drainage and an acceptable riding surface.

Ensure the operation results in pavement that conforms to the typical cross-section and the requirements specified for the final surface finish, however, it is the intention of this specification that the faulting at joints and cracks be eliminated and the overall riding characteristics be restored within the limits specified. To accomplish the smoothness required, grinding may not be required on 100 percent of the pavement surface.

During initial grinding operations, use the profiler to test the pavement surface as soon as the concrete has been ground full lane width. This initial testing is to aid the Contractor in evaluating the grinding methods and equipment being used. Subsequent to the initial testing, run daily profiles of each day's grinding the next working day.

Remove all grinding residue. Remove solid residue before it is blown by traffic action or wind. Do not allow residue to flow across lanes used by the traveling public or into gutters or drainage facilities.

257.04 Final Surface Finish. Produce a pavement surface that is true to grade with the ground area consisting of a longitudinal corduroy-type texture. Ensure the peaks of the ridges are approximately 1/16 inch (1.5 mm) higher than the grooves with 53 to 57 evenly spaced grooves per foot (174 to 187 per meter).

Measure the finished pavement surface for riding quality.

Produce a mainline riding surface which does not exceed an IRI of 95 inches per mile (1.50 m/km), nor any localized surface deviations in excess of 0.4 inches in 25 feet (10 mm in 7.6 m), as measured with the approved profiler. Use equipment conforming to Supplement 1058 and obtain a profile and smoothness measurements using ProVAL and Supplement 1110. The Engineer will witness the testing of the pavement surface's wheel paths. The wheel paths are located parallel to the centerline of the pavement and approximately 3 feet (0.9 m) from the center of the lane measured transversely. Maintain the alignment of the profiler with reference to the pavement edge at all times. Re-grind any 0.10 mile (0.16 km) sections with an IRI greater than 95 inches per mile (1.5 m/km) until the measured IRI is less than 95 inches per mile (1.5 m/km).

Provide the necessary traffic control and survey stationing for initial measurements or any subsequent measurements. Measure the entire length of pavement, event marking the profile runs such that the data can later be identified when the profile sensor(s) is within 1.0 foot (0.3 m) of any bridge deck, pressure relief joint, approach slab, or pavement not included in the grinding area identified in the plans or established by the Engineer.

Ensure transverse joints and cracks are flush with adjacent surfaces. The Engineer will visually inspect transverse joints and cracks to ensure that adjacent surfaces are in the same plane. Adjacent sides of joints or cracks within of 1/16 inch (1.5 mm) of each other will be considered flush. Ensure the transverse slope of the pavement is uniform to a degree that no depressions or misalignments of slope greater 1/4 inch in 12 feet (6 mm in 3.6 m) are present. Use a straightedge placed perpendicular to the centerline to measure depressions and misalignments. Straightedge requirements do not apply outside of area ground.

257.05 Method of Measurement. The Department will measure diamond grinding by the number of square yards (square meters) of pavement ground and accepted. The quantity of diamond grinding will be determined by multiplying the width specified on the plan by the total length of the diamond ground surface.

257.06 Basis of Payment. Payment is full compensation for furnishing all labor, materials, tools, equipment and incidentals and for doing all work involved in grinding the existing surface, removing residue, cleaning the pavement, and testing with a profiler.

The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
257	Square Yard (Square Meter)	Diamond Grinding Portland Cement Concrete Pavement

ITEM 258 LOAD TRANSFER RETROFIT

258.01 Description. This work consists of sawing slots across transverse cracks, cleaning the slot, injecting caulking filler, placing a dowel or deformed bar in the slot, and filling the slot with a patching material.

258.02 Materials. Furnish a one part silicone sealant which does not require a primer for bond to concrete and conforms to the following Table:

Properties	Requirements
Flow, ASTM D5893	0.3 inches(7.6 mm) maximum
Extrusion Rate, C1183 method A	75 to 350 grams/minute
Tack free time @ 77 °F ±3 °F (25 °C ±2 °C) – ASTM C679	20 to 90 minutes
Specific Gravity - ASTM D 792, Method A	1.010 to 1.515
Durometer Hardness - Shore A, cured 7 days @ 77 °F ±3 °F (25 °C ±2 °C) and 45 to 55% R.H.; ASTM D 2240	10 to 25 at 0 °F (-18 °C)
Tensile Stress -@ 150% elongation, 7 day cure @ 77 °F ±3 °F (25 °C ±2 °C) and 45 to 55% R.H.; ASTM D 412, Die C	45 psi (310 kPa) maximum
Elongation - 7 day cure @ 77 °F ±3 °F (25 °C ±2 °C) and 45 to 55% R.H.; ASTM D 412, Die C.	800% minimum
Bond to Concrete Mortar Briquettes - Air cured 12 days @ 77 °F ±3 °F (25 °C ±2°C);[1]	50 psi (345 kPa) minimum
Movement Capability and Adhesion [2]	Extend 100% and compress 50%; No adhesive or cohesive failure after 10 cycles at 0 °F (-18 °C)
Shelf Life	9 months from date of shipment from manufacturer

[1] Bond to Concrete Mortar Briquettes molded in accordance with AASHTO T 132 sawed in half and bonded with a thin section of sealant and tested in accordance with AASHTO T 132. Briquettes will be dried to constant weight in oven at 212 °F ±9 °F (100 °C ±5 °C).

[2] Movement Capability and Adhesion: Prepare 1-inch × 2-inch × 3-inch (25 mm × 50 mm × 75 mm) concrete blocks in accordance with ASTM C 719. A sawed face will be used for bond surface. Seal 2 inches (50 mm) of block leaving 1/2 inch (13 mm) on each end of specimen unsealed. The depth of sealant will be 3/8 inch (10 mm) and the width 1/2 inch (13 mm). Subject sealant to movement in accordance with ASTM C 719. The magnitude of the movement will be as specified, and the rate of extension or compression will be 1/8 inch (3.2 mm) per hour.

Furnish materials conforming to:

Aggregate 703.02.A.3
Curing material ..... 705.07, Type 2
Dowel bars ..... 709.13 or 705.01
Deformed bars ..... 705.01 or 709.00
Bar chairs ..... 709.14 or non-metallic material
Preformed filler..... 705.03
Patching material. Must meet the performance requirements of ASTM C928, Table 1, R3 concrete material with the following exceptions and additions:
Final Set Time (ASTM C403).... 25 minutes minimum
Length Change (ASTM C157)
@ 4 days.....±0.13% maximum
Freeze Thaw Durability Factor (ASTM C666) Procedure A @ 300 cycles or Procedure B @ 350 cycles,
Durability Factor: ..... 90% minimum

Furnish patching material according to the Departments Qualified Products List (QPL)

Mix prepackaged materials that contain all aggregates needed to produce the desired concrete as specified by the manufacturer. For bagged cementitious materials that need additional aggregates, grade the aggregate according to the patching material manufacturer's recommendation except ensure that 100% passes the 1/2-inch (12.5 mm) sieve and a minimum of 85 percent, by weight, passes the 3/8-inch (9.5 mm) sieve.

258.03 Equipment. Furnish equipment to create slots that has a power driven gang type assembly, consisting of diamond blade saws, capable of sawing a minimum of six sawcuts at one time to the required dimensions, without damage to the surrounding pavement.

Furnish jack hammers weighing less than 30 pounds (13.6 kg).

Furnish abrasive blast equipment capable of removing the saw slurry or other foreign material from the exposed surfaces leaving a clean, newly exposed concrete surface free of spalls, laitance, and all contaminants detrimental to achieving an adequate bond. Ensure water blasting pressure with abrasives in the water is 10,000 psi (690 bar) or less.

258.04 Construction. The Engineer will locate and mark cracks to be retrofitted. Provide the Engineer with aerosol spray paint to mark the cracks to be retrofit.

Construct 2 1/2-inch (65 mm) wide slots into the pavement to the required depth to place the center of the bar at mid-depth in the concrete slab. Ensure the slots are parallel to the centerline of the pavement. Saw the sides of the slots using the required sawing equipment. Make multiple saw cuts parallel to the centerline if necessary to properly remove material from the slot and to provide a level surface for the feet of the bar chairs. Chip out the concrete using jack hammers to create the slot. Do not operate jack hammers in a manner that causes damage to the surrounding concrete. Construct three slots, on one foot (0.3 m) centers, in each wheel path, as shown in the standard drawings.

Do not allow traffic across the crack once the concrete has been removed from the slots until all six retrofit bars are in place, cured and completed. Do not allow the tires of construction vehicles to travel on slots where concrete has been removed.

Clean the sides of the slots by approved blast methods to produce a rough surface. Ensure any blasting operation does not damage the surrounding pavement. Do not begin abrasive blasting operations until implementing reasonably available engineering controls to limit fugitive dust that are acceptable to the Engineer. Conform to state, regional, and local government agency requirements regarding control of dust generated by the blasting operation.

Caulk cracks at the bottom and sides of the slot with an approved silicone sealant in order to prevent any grout from entering the crack. Apply the sealant with a pressure applicator that forces it into the crack.

Place a 1/2 inch (13 mm) thick preformed filler board on dowel bars to maintain the crack, as shown in the standard drawings. Ensure the filler board fits tight around the dowel and to the bottom and sides of the slot. Maintain the filler board in a vertical position and tight to all sides during placement of the patching material. Ensure the filler board extends from the bottom of the slot to the surface of the pavement. If for any reason the filler board shifts during placement of the patching material, redo the dowel bar retrofit at no expense to the Department.

Ensure the bar chair firmly holds the bar centered in the slot. Obtain the Engineer's approval before using any bar chairs. The Engineer will reject any chair design that may allow movement of the bar during the placement of grout.

Provide smooth dowel bars 1 1/2 inches (38 mm) in diameter and 18 inches (460 mm) long. Center the filler board on dowel bars. Coat dowel bars with a thin uniform coat of new light form oil as a bond-breaking material just prior to installation in the slot. Place an expansion cap on each end of dowel bars prior to installation. Ensure the expansion caps are tight fitting and made of non-metallic material which will allow 1/4 inch (6 mm) movement at each end of the dowel.

Provide #11 (#36M) deformed bars 18 inches (460 mm) long.

Use two chairs to firmly hold the bar in the slot during placement of the patching material. Furnish chairs that are a nominal 2 1/2 inches (65 mm) wide and center the bar across the crack. Ensure dowel bars vary no more than 1/4 inch (6 mm) from parallel to the pavement surface and the centerline of the pavement. Just prior to placement of the patching material, make one or more passes of an air blast to provide a dust-free, clean slot to insure an adequate bond of the patching material.

Mix, place, and cure the patching material in accordance with the manufacturer's recommendations. Consolidate the patching material using a vibrator approved by the Engineer. Place the patching material in the slot and finish to produce a smooth, even surface.

Repair any damage to the pavement due to the Contractor's operation at no expense to the Department.

Cure the patching material for a minimum of four hours before placing any vehicle loads on the repair, or as directed by the Engineer.

258.05 Method of Measurement. The Department will measure the quantity of Retrofit Dowel Bars and Retrofit Deformed Bars by the actual number in the complete and accepted work.

258.06 Basis of Payment. Payment is full compensation for furnishing all materials including paint; sawing and cleaning the slots; installing dowel chairs, dowels, deformed bars, bond breaker material, dowel bar end caps, sealant/caulking material, filler material, and patching material.

The Department will not pay for additional work or materials required due to shifting of the filler board.

The Department will not pay for any additional work to repair damage to the pavement caused by the Contractor.

The Department will pay for accepted quantities at the contract unit price as follows:

Item	Unit	Description
258	Each	Retrofit Dowel Bar
258	Each	Retrofit Deformed Bar

300 BASES

ITEM 301 ASPHALT CONCRETE BASE

301.01 Description. This work consists of constructing a base course of aggregate and asphalt binder, mixed in a central plant and spread and compacted on a prepared surface. The requirements of Items 401, 402, and 403 apply with the additional requirements of this specification. The requirements of Item 440 apply except 440.04 and 440.06 do not apply.

301.02 Composition. Furnish aggregate for the mix that conforms to the following gradation:

Sieve Size		Total Percent Passing
2 inch	(50 mm)	100
1 inch	(25.0 mm)	75 to 100
1/2 inch	(12.5 mm)	50 to 85
No. 4	(4.75 mm)	25 to 60
No. 8	(2.36 mm)	15 to 45
No. 16	(1.18 mm)	10 to 35
No. 50	(300 µm)	3 to 18
No. 200	(75 µm)	1 to 7

Submit for OMM's approval the desired percentage of the aggregate passing the No. 4 (4.75 mm) sieve and blend of individual components. The Contractor may use reclaimed asphalt concrete pavement according to 440.05. OMM will establish the required binder content within a range of 4.7 to 7 percent. Do not make changes in these JMF values due to unsatisfactory results or other conditions except as authorized by OMM.

Do not start mix production without a preliminary JMF approval and 48 hour notification to District Testing. Final approval of a JMF will be based upon field verification. The JMF can be rejected for failure to verify in the plant or at the project.

301.03 Placement. Ensure that the maximum compacted depth of any one layer is 6 inches (150 mm). Ensure that the temperature of the mixture when delivered to the paver is a minimum of 250 °F (120 °C). Ensure the temperature of the mixture is sufficient for the roller coverage to be effective in compacting the mixture.

301.04 Acceptance. The Department will base acceptance of the asphalt concrete mix on the item specified in the Contract item description (i.e., 449).

301.05 Basis of Payment. Include the cost of asphalt material to coat vertical faces and seal joints and gutters in the contract unit price for Item 301. The Department will pay for accepted quantities at the contract prices as follows.

Item	Unit	Description
301	Cubic Yard (Cubic Meter)	Asphalt Concrete Base (____)

ITEM 302 ASPHALT CONCRETE BASE

302.01 Description
302.02 Composition
302.03 Placement
302.04 Acceptance
302.05 Basis of Payment

302.01 Description. This work consists of constructing a base course of aggregate and asphalt binder, mixed in a central plant and spread and compacted on a prepared surface. The requirements of Items 401, 402, 403, 440 apply with the additional requirements of this specification.

302.02 Composition

A. General. Furnish a mixture that conforms to the following gradation and properties:

TABLE 302.02-1 MIX COMPOSITION

Property	Limits
2 inch (50 mm)[1]	100
1 1/2 inch (37.5 mm)[1]	85 to 100
1 inch (25.0 mm)[1][2]	68 to 88
3/4 inch (19.0 mm) [1][2]	56 to 80
1/2 inch (12.5 mm)[1][2]	44 to 68
3/8 inch (9.5 mm)[1] [2]	37 to 60
No. 4 (4.75 mm)[1]	22 to 45
No. 8 (2.36 mm)[1]	14 to 35
No. 16 (1.18 mm)[1]	8 to 25
No. 30 (600 µm)[1]	6 to 18
No. 50 (300 µm) [1]	4 to 13
No. 200 (75 µm) [1]	2 to 6
Binder Content [3]	3.9 – 6.0 [4]
Blows [5]	70
Stability, lb [5] (N)	3000 (13,345) [Min]
Flow, 0.25 mm [5]	28 [Max]
Design Air Voids [6]	4.0
Voids in Mineral Aggregate %	12.0 [Min]

[1] Sieve, Percent Passing
[2] Provide aggregate to retain a minimum of 7 percent of the material on each of these sieves. This requirement applies to the gradation of the JMF and the mix production according to Item 403.
[3] See tables in 440.05
[4] Percent of total mix
[5] ASTM D 5581
[6] Percent, Supplement 1036

Use equipment that meets the requirements of a Level 3 laboratory as specified in Supplement 1041.

Produce batches of asphalt concrete base in the amount that will result in a compacted specimen 3.75 ±0.05 inch (95 ±1.3 mm) in height. This amount is about 4050 grams.

B. Compaction of Specimens. Fill the mold with asphalt concrete base by placing approximately one-half of the batch in the mold and spading it vigorously with a heated spatula or trowel 15 times around the perimeter and ten times in the interior. Place the second half of the batch in the mold and spade the mixture in the same manner.

C. Stability Correlation Ratios. Convert measured stability values for specimens that depart from the standard 3.75-inch (95 mm) thickness to an equivalent 3.75-inch (95 mm) value by multiplying the stability value by the appropriate correlation ratio as follows:

TABLE 302.02-2 STABILITY CORRELATION RATIOS

Approximate Thickness of Specimen, inches (mm)		Correlation Ratio
3 1/2	(89)	1.12
3 9/16	(90)	1.09
3 5/8	(92)	1.06
3 11/16	(94)	1.03
3 3/4	(95)	1.00
3 13/16	(97)	0.97
3 7/8	(98)	0.95
3 15/16	(100)	0.92
4	(102)	0.90

302.03 Placement. Provide and operate anti-segregation equipment in accordance with the requirements of 401.03.C excluding the use of remixing pavers. Use anti-segregation equipment for all project line items containing 1000 or more cubic yards (766 cubic meters) of Item 302 Asphalt Concrete Base. Ensure that the compacted depth of any one layer is a minimum of 4 inches (100 mm) and a maximum of 7.75 inches (190 mm). If the plan thickness is 7.0-7.75 inches (178 mm – 190 mm) and District Testing confirms the JMF and mixture production has 95% passing the 1.50 inch (37.5 mm) sieve, the 302 may be placed in two lifts if requested by the Contractor. One lift of plan thickness will be required if top size aggregate dragging occurs. Ensure that the temperature of the mixture when delivered to the paver is a minimum of 250 °F (120 °C). Ensure the temperature of the mixture is sufficient for the roller coverage to be effective in compacting the mixture.

302.04 Acceptance. The Department will base acceptance of the asphalt concrete mix on the method specified in the Contract line item description (i.e. 449).

302.05 Basis of Payment. Include the cost of asphalt material to coat vertical faces and seal joints and gutters in the contract unit price for Item 302. The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
302	Cubic Yard (Cubic Meter)	Asphalt Concrete Base (____)

ITEM 304 AGGREGATE BASE

304.01 Description. This work consists of furnishing, placing, and compacting one or more courses of aggregate on a prepared surface, including furnishing and incorporating all water required for compaction.

304.02 Materials. Furnish materials conforming to 703.17.

304.03 Before Spreading. Sample the material stockpile, according to ASTM D75, to determine the initial moisture content to be used for compaction. Create the moisture-density curve according to AASHTO T 99, Method C or Method D, to determine the optimum moisture content. For projects when the total volume of material is less than 1000 cubic yards, the optimum moisture content may be obtained from a moisture-density curve that was performed on the material within 1 year prior to the date of placement. Submit moisture-density test results to the Engineer.

Use material that has reasonably uniform moisture content. Ensure the moisture content is not less than 2 percent below the optimum moisture content before spreading. Add water to the stockpile if necessary to meet this moisture requirement.

Handle the material in a manner to minimize segregation. If segregation occurs, thoroughly mix or regrade the stockpile.

304.04 Spreading. Spread the material on the prepared surface. Do not use frozen material and do not spread on frozen surfaces.

Do not exceed a compacted lift thickness of 8 inches when using vibratory rollers with effective weights greater than 12 tons. Do not exceed a compacted lift thickness of 6 inches when using vibratory rollers with effective weights from 10 to 12 tons. Do not exceed a maximum compacted lift thickness of 4 inches when these vibratory rollers are not used. The effective weight of a vibratory roller is the weight plus the centrifugal force from vibration. Submit documentation from the manufacturer that shows the vibratory roller meets the minimum effective weight requirements.

Place the material in two or more approximately equal lifts when the specified compacted thickness exceeds the maximum allowed.

Place the material with self-propelled spreading machines capable of placing the material true to line and grade. Spreading machines such as spreader boxes or pavers are allowed. Do not use graders or dozers without spreader boxes to spread the material except for areas described in the next paragraph. Spread the material such that it minimizes segregation and requires minimal blading or manipulation. The Department may perform in-place gradation testing in areas that are visually segregated according to Supplement 1090.

The Contractor may use hand-placing methods, dozers or graders when the total area of the material is 2000 square yards or less or in small areas where self-propelled spreading machines are impractical. Small areas include lane widths less than 12 feet or lengths less than 1000 feet. The Department will not take in-place gradation tests in these small areas.

The Department may test for in-place gradation after spreading but before compaction testing according to Supplement 1090.

304.05 Compaction. Add water or dry the material to bring it to within 2 percent of the optimum moisture content before compacting. Maintain the moisture content within this range during all compaction operations. The Engineer will determine the percentage of moisture to apply or to be dried from the material. Uniformly apply the water or dry the material throughout the lift and in a manner that does not soften or disturb the lower courses. Reduce the moisture content if the material becomes unstable during the compaction operation.

Compact each lift of material immediately after spreading. Use rollers that correspond with the lift thickness as described in 304.04. The Contractor may use lighter rollers or vibratory equipment in small areas as specified in 304.04 or when heavier rollers are not practical. Approved compaction equipment may consist of vibratory rollers, static rollers, or vibratory equipment.

At the beginning of the compaction operation, construct a test section according to Supplement 1015. Use a minimum compactive effort of eight passes to construct the test section. Use and adjust the vibration on the vibratory rollers to maximize the density and stability. Construct a new test section when the material changes or when the supporting materials change appreciably.

Unless otherwise specified in the Contract Documents, the Engineer will perform all compaction tests according to Supplement 1015.

The Engineer will use 98 percent of the test section maximum dry density for acceptance of the production material. Use at least the same number of passes and compactive effort used to obtain the test section maximum dry density for the production material. At a minimum, use eight passes in the production area. The Engineer may reduce the minimum passes if the passes are detrimental to compaction.

The Engineer may check the production material density before or after the finishing operations.

Maintain the surface of each lift during the compaction operations in such a manner that the surface texture is reasonably uniform and the material is firmly keyed.

Cover the aggregate base with the next layer of pavement before the end of the construction season. If the aggregate base is not covered up, then assume all liability for contamination of, damage to and instability of the base, subgrade and underdrains.

Provide drainage and maintain the material according to 203.04.A.

304.06 Finished Surface. Ensure that the finished surface does not vary more than 3/8 inch from a 10-foot straightedge parallel to the centerline or more than 1/2 inch from a template conforming to the required cross-section. Furnish straightedges, templates, or other devices satisfactory to the Engineer, and check the surface for conformance with these requirements.

Do not construct the aggregate base at a consistent depth below the required minimum compacted depth thickness. When the depth is found to be less than the required depth, provide the Engineer with a written corrective action plan for approval.

304.07 Method of Measurement. The Department will measure Aggregate Base by the number of cubic yards computed from the profile grade and typical sections, compacted in place.

Where variable depth is specified, the Department will measure the number of cubic yards of aggregate base by converting from weight using the following conversion factors:

TABLE 304.07-1

Material	Conversion Factor
Crushed stone	4000 lb/yd³
Crushed gravel	4000 lb/yd³
Crushed slag [1]	
less than 90 lb/ft³	3600 lb/yd³
90 to 100 lb/ft³	4000 lb/yd³
more than 100 lb/ft³	4500 lb/yd³
Granulated slag	2800 lb/yd³

[1] Based on average dry rodded weight of standard size of slag aggregates on record at the Laboratory. The conversion factors listed are the long gradation weights. These numbers are based on the dry rodded weights of No. 67, 57, or 8 gradation. The Department will determine slag weights based on weights obtained from the original source.

The Department will verify that the moisture content of the delivered material is less than 2 percent above saturated surface dry (SSD). If the moisture content is greater than 2 percent above SSD, then the Department will calculate the number of cubic yards based on the dry density and dry weight.

The Department will determine the pounds per cubic yard for aggregate mixtures by using 100 percent of the test section maximum dry density obtained in 304.05.

304.08 Basis of Payment. The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
304	Cubic Yard	Aggregate Base

ITEM 305 PORTLAND CEMENT CONCRETE BASE

305.01 Description
305.02 Construction
305.03 Method of Measurement
305.04 Basis of Payment

305.01 Description. This work consists of constructing a portland cement concrete base on a prepared surface.

305.02 Construction. The requirements of Item 451 apply, except as follows.

Do not comply with the requirements of 451.08.

Provide dowels at transverse contraction joints in mainline pavement, ramps, acceleration/deceleration lanes, or collector/distributor lanes. Dowels for contraction joints in concrete shoulders on mainline pavement, ramps, acceleration/deceleration lanes, or collector/distributor lanes are not required unless the contraction joint is located within 500 feet (150 m) of a pressure relief joint.

Do not place construction joints within 6 feet (1.8 m) of another parallel joint.

Modify the curing membrane application rate specified in 451.11 to 200 square feet per gallon (5 m^2/L) of treated pavement surface.

Produce a final surface with a uniform, gritty, longitudinal, or transverse texture using a broom drag in either direction.

Ensure that pavement surface variations do not exceed 1/4 inch in 10 feet (6 mm in 3 m).

Impressing station numbers into the plastic concrete as specified in 451.10 is not required.

305.03 Method of Measurement. The Department will measure Concrete Base by the number of square yards (square meters) completed and accepted in place. The width equals the base width shown on the typical cross-section of the plans plus additional widening as the Engineer directs in writing. The Department will field measure the length along the centerline of each roadway or ramp.

305.04 Basis of Payment. For base found deficient in thickness, the Department will pay a reduced price according to 451.18.A.

The Department will not make additional payment over the Contract unit price for any base with an average thickness in excess of that shown on the plans.

For base found deficient in strength, the Department will pay a reduced price according to 451.18.B and table 451.19-2. Use the determination and pay procedures for non QC/QA items.

The Department will pay for accepted quantities at the contract price as follows.

Item	Unit	Description
305	Square Yard (Square Meter)	Concrete Base

ITEM 320 RUBBLIZE AND ROLL

320.01 Description. This work consists of rubblizing and rolling reinforced concrete pavement before placing an asphalt concrete pavement.

320.02 Materials. Furnish filler aggregate conforming to Item 304.

320.03 Equipment. Use a self-contained and self-propelled unit of either the resonant frequency type or the multiple head breaker type for rubblizing the concrete pavement.

If using a resonant frequency unit, ensure that it is capable of producing low amplitude, 2000-pound-force (8900 N) blows at a rate of not less than 44 blows per second.

If using a multiple head breaker unit, ensure that it has the capability of rubblizing the full 12-foot (3.6 m) lane width in a single pass. Ensure the breaking head consists of 12 to 16 hammers, each weighing 1000 to 1500 pounds (450 to 680 kg). Attach each hammer to a hydraulic lift cylinder that operates as an independent unit, develops 2000 to 12,000 foot-pounds (2700 to 16,000 J) of energy depending on lift height selected, cycles at a rate of 30 to 35 impacts per minute, and has a maximum lift height of 60 inches (1.5 m).

Use a vibratory steel wheel roller having a total weight of not less than 10 tons (9 metric tons).

320.04 Construction Details. Make a full depth saw cut or cut load transfer devices at joints on ramps or mainline where the rubblizing abuts concrete pavement or approach slabs that are to remain in place permanently or temporarily for maintenance of traffic.

Before the rubblizing operations begin, the Engineer will designate a test section. Rubblize the test section according to this specification. After rubblizing, excavate a test pit, where the Engineer designates, to check for proper particle size throughout the thickness of the concrete. Fill in the test pit using the excavated material and additional filler aggregate as necessary. Compact the test pit as part of the rolling operation. Excavate at least one test pit, at the location designated by the Engineer, for each production day or every 7040 square yards (5886 m^2), whichever is greater.

Adjust the rubblizing procedure to maintain the proper particle sizes. Control the operating speed of the rubblizing equipment such that: 75% of the rubblized particles above the reinforcing steel are reduced to 3 inches (75 mm) in their largest dimension, 90% of the rubblized particles below the reinforcing steel do not exceed 9 inches (230 mm) in their largest dimension, and no particles exceed 12 inches (300 mm) in their largest dimension.

Before placing the initial asphalt concrete course, compact the rubblized pavement with two passes of the vibratory roller. Operate the roller in the vibratory mode and at a speed not to exceed 6 feet (1.8 m) per second.

Leave steel reinforcement in place in the rubblized pavement. However, cut off any exposed steel reinforcement below the surface and remove it from the site.

Fill depressions 1 inch (25 mm) or greater in depth compared to the immediate surrounding area resulting from the rubblizing, the compactive effort, or the steel reinforcement removal, with the filler aggregate. Strike off excess aggregate level with the surrounding area. Compact filled depressions with the same roller and compactive effort previously described.

Do not allow traffic on the rubblized pavement before the asphalt concrete base and intermediate courses are in place.

Do not allow more than 48 hours to elapse between rubblizing the pavement and placing the initial asphalt concrete course. However, in the event of rain, the Engineer may waive this time limitation to allow sufficient time for the rubblized pavement to dry to the Engineer's satisfaction. If the Engineer waives the time limitation, cease rubblizing the pavement until the Engineer allows paving to resume.

320.05 Method of Measurement. The Department will measure Rubblize and Roll by the number of square yards (square meters). The Engineer will use the width of the concrete pavement prior to rubblizing and will measure the length along the centerline of each roadway or ramp.

The Department will measure the Filler Aggregate by the number of cubic yards (cubic meters) furnished, placed, and compacted.

320.06 Basis of Payment. The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
320	Square Yard (Square Meter)	Rubblize and Roll
320	Cubic Yard (Cubic Meter)	Filler Aggregate

ITEM 321 CRACKING AND SEATING NON-REINFORCED CONCRETE PAVEMENT

321.01 Description. This work consists of cracking and seating non-reinforced concrete pavement or concrete base before placing an asphalt concrete pavement.

321.02 Equipment. Use devices for cracking the concrete capable of producing the desired crack pattern without extensive spalling or excessive shattering. Extensive spalling is spalling over 1 1/4 inches (30 mm) in depth. Do not use whiphammers.

Use watering equipment capable of wetting the cracked surface uniformly to reveal the crack pattern.

Use a 50-ton (45 metric tons) pneumatic tire roller conforming to the requirements of Item 204 for seating the cracked concrete slabs. Use pneumatic tire towing equipment capable of moving the roller forward and backward along predetermined lines.

321.03 Construction Details. Demonstrate, to the Engineer's satisfaction, the ability of the selected equipment and procedures to produce cracking of acceptable quality by cracking at least three, but no more than five, concrete slabs. When cracking the test slabs, furnish and apply water to dampen the cracked concrete to enhance visual determination of the cracking pattern. In addition to 107.07, provide positive provision to contain any flying debris during cracking operations.

Crack concrete into nominal 4 × 4-foot (1.2 × 1.2 m) segments. In the event panels are already cracked into segments, crack these segments further into nominally equal-sized square or rectangular pieces having longitudinal and transverse dimensions not more than 5 feet (1.5 m) and not less than 3 feet (0.9 m), wherever feasible. Do not allow the cracking equipment to impact the slabs within 1 foot (0.3 m) of another break line, joint, or the edge of the concrete.

Furnish and apply water to a check section of three to five slabs at least once each day to verify that a satisfactory crack pattern is being maintained. Make adjustments to the energy or striking pattern when the Engineer deems it necessary, based on the check sections.

Roll the cracked concrete until the concrete pieces are firmly seated. Perform rolling with at least two coverages as specified in Item 204. The Engineer will determine the maximum number of coverages of the roller on the test sections to ensure seating without damage to the concrete.

Before placing the asphalt concrete, remove all loose pieces of broken concrete that are not firmly seated. Repair all voids, such as spalls, removed loose pieces, joints, or cracks that, in the Engineer's opinion, will make uniform compaction of

the first asphalt concrete course difficult. Repair voids by applying 407 tack coat, filling with asphalt concrete, and compacting as directed by the Engineer.

Do not allow traffic on the cracked concrete before the asphalt concrete base and intermediate courses are in place.

321.04 Method of Measurement. The Engineer will measure the area of non-reinforced concrete pavement or concrete base satisfactorily cracked and seated in square yards (square meters). The Engineer will use the width of the concrete pavement prior to cracking and will measure the length along the centerline of each roadway or ramp.

321.05 Basis of Payment. Include the cost of all crack pattern test and check sections including water; and for repairing of joint, cracks, spalls, and voids in the contract unit price for Cracking and Seating Non-Reinforced Concrete Pavement.

The Department will pay for the accepted quantities at the contract price as follows.

Item	Unit	Description
321	Square Yard (Square Meter)	Cracking and Seating Non- Reinforced Concrete Pavement

400 FLEXIBLE PAVEMENT

ITEM 401 ASPHALT CONCRETE FIELD OPERATIONS

401.01 Description. This specification describes the field operation requirements for placing all types of asphalt concrete material used in pavement surface, intermediate, and base courses. Deviations from these general requirements are covered in the specific requirements for each material type according to the appropriate contract item or items.

Use an approved Job Mix Formula (JMF). Control all field operations to ensure that the mixture placed is uniform in composition, conforms to the specification requirements, is free of any defect (ex. segregation, tenderness, lack of mixture and texture uniformity, raveling, flushing, rutting, holes, debris, etc.) within the Contractor's control at project completion.

401.02 Materials. Furnish materials conforming to:

Asphalt material
(401.06, 401.08.D, 401.11) 702.01, 702.04,
.....702.09, 702.12, or 702.13

401.03 Equipment. Provide equipment meeting the requirements below:

A. Hauling Equipment. Use trucks for hauling asphalt concrete that have tight, clean, smooth metal beds. Equip all truck beds with a securely fastened, waterproof cover of suitable material to protect the mixture from wind and weather during transport. In addition to covers, insulate all truck beds if transporting asphalt concrete at prevailing air temperatures below 50 □F (10 □C) or if the haul distance exceeds 20 miles (32 km).

B. Spreading Equipment. Use self-contained spreading equipment of sufficient size, power, and stability to receive, distribute, and strike-off the asphalt concrete at rates and widths meeting the typical sections and other details shown on the plans. Use spreading equipment that has automatic control systems that maintain the screed in a constant position relative to profile and cross-slope references. Ensure control of the screed position is reasonably independent of irregularities in the underlying surface and of the spreader operation. Equip asphalt spreading equipment to prevent segregation of the asphalt concrete when the material moves from the hopper to the

screed. Use means and methods approved by the asphalt spreader manufacturer consisting of but not limited to any combination of chain curtains, deflector plates, kickback panels, reverse augers, or other such devices.

When a safety edge is required, attach a device to the screed that confines the material at the end gate and extrudes it in such a way that results in a compacted wedge shape pavement edge of approximately 30 degrees and not steeper than 40 degrees. Ensure the device maintains contact with the prepared surface and allows for transition to crossroads, driveways, and obstructions. Do not use conventional single plate strikeoff. Obtain the Engineer's approval for short sections of handwork when necessary for transitions, turnouts, or other areas.

The Engineer will base final approval of spreading equipment on the demonstrated capability of the equipment to place the mixture to the required cross-section, profile and alignment in an acceptable, finished condition ready for compaction.

Where the use of standard full-scale spreading equipment is impractical due to the size or irregularity of the area to be paved, use specialized equipment or hand methods approved by the Engineer to spread the asphalt concrete.

C. Anti-Segregation Equipment. When anti-segregation equipment is specified, provide a Material Transfer Vehicle (MTV) with paver hopper insert; a Material Transfer Device (MTD) with paver hopper insert; or a remixing paver specifically manufactured to eliminate segregation. Use paver hopper inserts with a minimum capacity of 10 tons (9 metric tons). Remixing may be done by the MTV, MTD, in the paver hopper insert, or by the remixing paver.

Provide and operate equipment in a manner that does not result in physical segregation and limits temperature differentials to less than 35 °F (19.5 °C) throughout the mixture as measured behind the paver and before rolling. Construct a test strip according to 401.08.B to demonstrate the equipment meets these requirements.

Use anti-segregation equipment when specified for paving intermediate and surface courses of uniform thickness on all mainline lanes of the traveled way including express lanes, collector-distributor lanes, continuous center turn lanes, acceleration/ deceleration lanes, and ramp lanes.

D. Compaction Equipment. Provide steel wheel or pneumatic tire rollers. Ensure the rollers fully and satisfactorily provide the required compaction, are mechanically sound, and meet asphalt industry standards. The Department retains the right to reject the use of rollers that are not in good repair or are not designed to do the work required.

Equip drums and wheels with the necessary accessories to prevent adhesion of the mixture.

401.04 Notification. Notify the Engineer at least 24 hours before starting paving. After starting, if paving operations stop for 1 week or more, notify the Engineer at least 24 hours before resuming paving.

401.05 Weather Limitations. Place asphalt concrete only if the surface is dry and if weather conditions are such to ensure proper handling, finishing, and compaction. Never place asphalt concrete if the surface temperature is below the minimum established in Table 401.05-1. Chemical warm mix asphalt (WMA) additives on the approved list may be used to allow placement in colder temperatures and to place asphalt concrete later in the year. Water-injected WMA does not apply.

TABLE 401.05-1 WEATHER LIMITATIONS

Course Thickness	Minimum Surface Temperature	
	Without Chemical WMA	With Chemical WMA[1]
3.0 inches (75 mm) and over [2]	36 °F (2 °C)	32 °F (0 °C)
1.5 to 2.9 inches (38 to 74 mm)	40 °F (5 °C)	32 °F (0 °C)
1.0 to 1.4 inches (25 to 37 mm)	50 °F (10 °C)	40 °F (5 °C)
Less than 1.0 inch (25 mm)	60 °F (16 °C)	50 °F (10 °C)
Variable Intermediate, 0 to 3.0 inches (0 to 75 mm)	40 °F (5 °C)	32 °F (0 °C)

[1] Only use chemical WMA additives on the approved list. Chemical WMA additive must be in-line blended per S-1053, Method A, at the asphalt concrete mix plant.

[2] When paving on an aggregate base or subgrade, use a minimum air temperature of 40 °F (5 °C), or a minimum air temperature of 32 °F (0 °C) when using chemical WMA.

In addition to the above surface temperature requirements, do not place surface courses if the air temperature is less than 40 °F (5 °C) without chemical WMA or 32 °F (0 °C) with chemical WMA.

For any surface course with a polymer modified asphalt binder, ensure that the paving surface and the air temperature are at least 50 °F (10 °C) without chemical WMA or at least 40 °F (5 °C) with chemical WMA. In addition, for 424 mixes ensure the paving surface and air temperatures are at least 60 °F (15 °C) without chemical WMA or at least 50 °F (10 °C) with chemical WMA.

Do not schedule the placement of any surface course with a polymer modified asphalt binder after November 1, regardless of pavement and air temperatures. Obtain the approval of the Engineer to place any surface course with a polymer modified asphalt binder after November 1. Use an approved chemical WMA additive during production, if approved, but the minimum pavement and air temperatures in Table 401.05-1 apply.

The use of chemical WMA, as described above, may be denied if density acceptance does not achieve at least a pay factor of 1.00.

401.06 Conditioning Existing Surface. Clean the surface on which the asphalt concrete is to be placed and keep it free of accumulations of materials that would, in the judgment of the Engineer, contaminate the mixture, prevent bonding, or interfere with spreading operations. Where approved subgrade, aggregate, or pavement courses previously constructed under the Contract become loosened, rutted, or otherwise defective, correct the deficiency according to the contract item or items involved before spreading a subsequent pavement course.

If a quantity of asphalt concrete is specified for use in spot leveling or patching, spread and compact the material needed to make the corrections as directed by the Engineer.

If placing asphalt concrete against a vertical pavement face, curb, gutter, manhole, or other structure, clean the surface of foreign material and apply a thick, uniform coating of certified 702.01 PG binder, 702.09 Hot Applied Asphaltic Joint Adhesive, or 702.13 SBR Asphalt Emulsion to provide 100 percent coverage.

401.07 Hauling. Before loading, apply a thin coating of an approved release agent to the inside surfaces of the truck bed to prevent adhesion of mixture to the bed surfaces. OMM maintains a list of approved release agents. Do not use diesel or fuel oil for this purpose. Any use of non-approved release agent, diesel, or fuel oil may result in suspension of truck, driver, or both for up to one year. Drain truck beds after applying the release agent and before loading.

Cover truck beds with the secure, waterproof cover before hauling. At the request of the Engineer, remove bed covers before dumping into the paver. The Engineer may reject loads exhibiting segregation. Obtain OMM approval before making any procedure changes for better mix handling.

The Engineer will verify the required temperature of the mixture on arrival at the project site based on the temperature range in the JMF and heat losses in transit.

Completely discharge the mixture into the spreading equipment within 90 minutes of loading. Ensure the entire quantity of mixture discharges smoothly into the spreading equipment.

Do not clean out truck beds on the roadway ahead of the paver. Provide a location away from the roadway or off the project for cleaning trucks. If there is excessive sticking of material in truck beds, the sticking is in areas of the truck that would indicate excessive cooling of the mix (front corners, bottom, etc.) due to a long haul, and it is not resolved in a reasonable time, the Engineer will require an insulated bed.

Do not exceed a haul distance of 50 miles (80 km) from the asphalt concrete plant to the paving site regardless of prevailing air temperature except by specific permission of the Department.

401.08 Placement Operations. Do not co-mingle multiple JMFs in the same asphalt paver. Spread the mixture at a rate calculated using the specified thickness and the compacted width of the pavement course being placed, and the weight-to-volume conversion factors established by OMM. If there is not an OMM established rate, the conversion factors in 440.07 apply. Maintain the actual rate of spreading equal to the required calculated rate within the tolerance specified in 401.08.A. For pavement courses specified for leveling, the actual rate of spreading may vary from the required calculated rate as approved by the Engineer to accomplish the intended purpose.

Spread the mixture using approved equipment or methods. Preheat screeds and extensions before placing any asphalt concrete. Use side plates sufficient to contain the mixture laterally during spreading. Use only screed extensions, rigid or extendable, having the same features as the main screed including, but not limited

to, vibration, heating, pre-strikeoffs, and tamping bars. When using front-mounted hydraulically extendable screeds at a fixed paving width use full width auger extensions and full tunnel extensions. When using fixed screed extensions use full width auger extensions and full tunnel extensions. Do not allow a buildup of excess material in front of the screed. Where excessive buildup of material is not controlled, the Engineer will require paver changes to correct the problem.

Ensure the paver operation, screed, screed extension, and mix design provide a mat, before compaction, that is free of texture inconsistencies, shadowing, streaking, tearing, pulling, or other deficiencies. Take immediate action to correct the paver operation, screed, screed extensions, or mix design. The Engineer may stop placement until corrections are completed.

Use strike-off plates/strike-off extensions only on irregular areas such as mailbox turnouts, driveway turnouts, and other irregular non-travelled roadway areas. The Engineer may approve the use of strike-off plates/extensions on variable width shoulders if the use of a standard extendable screed extension with the same features as the main screed is not practicable. Perform supplemental hand forming and tamping where irregularities develop and where placing the mixture by hand methods.

Take prompt corrective action if placed mixture exhibits any defect (ex. segregation, tenderness, lack of mixture and texture uniformity, raveling, flushing, rutting, holes, debris, etc.) within the Contractor's control and as determined by the Engineer.

Coordinate the spreading operation with the rate of production and delivery of the mixture to attain uniform, continuous progress. Avoid erratic spreader operation due to irregular contact with the hauling vehicle, surging in the feed, distribution of the mixture, or other cause. Maintain sufficient control of the spreading equipment with regard to line and grade references so that the pavement course, when compacted as specified, is in reasonable conformance with the Contract Documents.

Do not displace or damage bridge deck waterproofing membranes during spreading operations on the membranes.

Cease the paving operation in the event of equipment breakdown, inability to consistently provide a mat free of physical segregation, inability to consistently meet the temperature differential requirements, or any combination. Do not resume paving until equipment is replaced with suitable equipment.

When anti-segregation equipment is required the Engineer may allow paving to continue if an isolated area of mat temperature differential is in excess of 35 °F (19.5 °C). The Engineer may require additional evaluation of the area to determine the acceptability of the material.

A. Application Rate. If a uniform course is specified, make checks and adjustments to maintain the application rate within a tolerance of ±5 percent of the required calculated weight per unit of area.

If a variable depth course is specified, place the mixture as shown on the plans.

B. Anti-Segregation Test Strip. When using anti-segregation equipment, perform a test strip a minimum of 1000 feet (300 m) in length on the first day or

night of paving any JMF. Notify the Engineer a minimum of 24 hours before performing the test strip. Demonstrate to the Engineer that the selected equipment is not physically segregating the mix and consistently limits the temperature differential of the mat surface, measured transversely behind the paver and before rolling, to 35 °F (19.5 °C) or less. Document results of each test strip on Department form CA-FP-5. Remove equipment or JMF that provides a mat with physical segregation, does not meet the temperature differential requirement, or both. Perform a new test strip any time placement equipment or JMF is replaced. If the Contractor is unable to produce a satisfactory test strip in two attempts per JMF, cease paving and provide a written plan to the DCA for approval before continuing the paving operation.

C. Night Work. Do not start night work or carry on day work into night work without operating an adequate and approved lighting system. Night work is work performed from 30 minutes after sunset to 30 minutes before sunrise.

Operation of adequate lighting system consists of furnishing, installing, operating, maintaining, moving, and removing nighttime lighting to illuminate construction work areas for night work. Obtain the Engineer's approval of the lighting at the beginning of the project and before starting the paving operation by measuring the luminance.

Provide an illuminated zone around all operating machinery. Provide an illuminated zone of at least 5 Foot-candles (55 lux) of lighting luminance in the immediate vicinity of pavers, rollers, grinding equipment, material transfer vehicles, etc., and at least 1 Foot-candle (10 lux) at 25 feet (7.6 m) from this equipment. Provide an illuminated zone of at least 5 Foot-candles (55 lux) of lighting luminance in the immediate vicinity of coring equipment and at least 1 Foot-candle (10 lux) at 10 feet (3 m). Position the light sources so they don't interfere with or impede traffic in any direction and do not cause glare for motorists or point onto adjacent properties. Provide a photometer capable of measuring the level of luminance on each night project. Take luminance measurements at a height of 20 inches (500 millimeters) above the roadway.

Obtain the luminance level any time requested by the Engineer. Test the illumination levels on the site each time a change in lighting configuration is made. Replace non-functioning lamps immediately. Check the luminaires aiming daily. Clean the luminaires regularly. Correct any deficient lighting within one hour or the Engineer will terminate construction activities.

When the total project includes more than one continuous lane mile (including bridges) of surface course paving in combination with night paving and there is no pay item for anti-segregation equipment, provide anti-segregation equipment according to 401.03.C, for only the surface course. Construct a test strip according to 401.08.B. No additional payment will be made for this anti-segregation equipment.

D. Joints. Place the asphalt concrete mixture as continuous as possible. Set up joints at the proper height above the adjacent construction to receive maximum compaction. Where the edge of the new pavement is significantly rounded, trim it to a vertical face before placing the adjacent pavement. On projects where traffic is

allowed to cross the edge of the new pavement lane, complete the longitudinal joint of the adjacent lane or shoulder within 24 hours.

Construct longitudinal joints using string line or other controls as a point of reference to provide a straight longitudinal joint. Before placing adjacent pavement, trim any locations along the longitudinal joint that deviate horizontally from the point of reference. Maintain a consistent overlap of 1 to 1 1/2 inches (25 to 38 mm) on adjacent pavement when closing longitudinal joints. Where phasing for maintenance of traffic will not allow lapping cold longitudinal joints according to Standard Construction Drawing BP-3.1, provide a minimum of 6 inches (150 mm) offset between cold joints for each course placed.

Form hot longitudinal joints using pavers operating in contiguous lanes, one just ahead of the other. Maintain the distance between pavers in adjacent lanes such that it does not exceed the distance that a normal size load of mixture will cover. Alternate loads of mixture between the pavers. Do not allow rollers performing the initial rolling operation in one lane closer than 12 inches (0.3 m) to the longitudinal joint until the adjacent lane is placed. Instead of hot joint construction using multiple pavers, the Contractor may use full width construction with a single unit paver.

Seal all cold longitudinal joints by coating the entire face of the cold joint with a certified 702.01 PG binder or 702.09 Hot Applied Asphaltic Joint Adhesive to provide 100 percent coverage of the joint face and extend at least 1/2 inch (13 mm) on both surfaces.

Seal all cold transverse construction joints with a certified 702.01 PG binder, 702.09 Hot Applied Asphaltic Joint Adhesive, or 702.13 SBR Asphalt Emulsion to provide 100 percent coverage of the joint; or with a certified 702.04 or 702.12 emulsified asphalt applied at a rate of 0.25 gallon per square yard (1 L/m²). For surface courses, form or cut all transverse construction joints to a vertical before sealing.

After completion of the surface course, seal gutters with certified 702.01 PG binder as directed by the Engineer. Apply the binder at a uniform width of approximately 4 inches (100 mm) and at a rate just sufficient to fill surface voids. The Contractor may open the surface course to traffic before sealing the gutters.

E. Compaction. Unless otherwise directed, begin rolling at the sides and proceed longitudinally parallel to the centerline at a slow, uniform speed. On superelevated curves, begin rolling at the low side and progress toward the high side. After each coverage or complete round trip, move the roller towards the crown of the road to begin the next pass, overlapping the previous pass by at least one-half the width of the previous pass. Continue rolling until full coverage of the course is complete and all roller marks are eliminated.

When constructing a longitudinal joint, roll the joint then follow the applicable rolling procedure.

During compaction, take care to prevent displacement of the mat edge and changes to the surface profile. Where displacement or changes occur, correct the area immediately in a manner satisfactory to the Engineer. When constructing a safety edge, operate the rollers in a manner that does not damage or obliterate the tapered edge. Do not roll the taper.

Keep drums and wheels properly moistened with water, water containing a detergent, or water containing an approved additive. Do not use excess liquid.

Cease production if compaction causes bumps in the mix or the mix is excessively tender.

Compact shoulders using the same equipment and procedures as used on the mainline pavement. Along curbs, headers, walls, and in other areas not accessible to rollers, thoroughly compact the mixture with hot, hand tampers or with mechanical tampers. On depressed areas, the Contractor may use trench rollers or rollers fitted with compression strips.

Replace mixture that becomes loose, broken, contaminated, or otherwise defective with fresh, hot mixture. Compact it to match with the surrounding area.

401.09 Asphalt Binder Compatibility. If excess fat spots, regular random areas of flushing, or excess drain down occur on a project that are not attributable to over rolling, plant operation, or mix quality compared to the JMF, the Department will consider the neat asphalt binder incompatible with the polymer additive or other mix materials. The Department will reject any on-hand asphalt binder because of incompatibility. The Department will determine if problem areas can be corrected, or if removal and replacement is required. Demonstrate to OMM through testing analysis the compatibility of another asphalt binder and that proper equipment is in place in order to be allowed to resume.

401.10 Surface Tolerances. If a longitudinal profile is specified by elevations on the plans, do not allow the completed pavement surface to deviate more than 1/2 inch (13 mm) at any point from parallel with the specified profile. Before placing the surface course, check the profile of the preceding course at 50-foot (15 m) intervals along the outside edge of each traffic lane and along any additional line described in superelevation tables, and submit to the Engineer a tabulation of all results that includes documentation of all deviations from the above tolerance. Perform corrective work necessary for compliance with the profile tolerance before placing the surface course. The requirements of this paragraph do not apply to small incidental areas of pavement less than 500 feet (150 m) in length.

Do not vary the transverse slope of the surface of any completed course from the specified slope by more than 3/8 inch in 10 feet (10 mm in 3 m).

For surface and intermediate courses, do not vary the surface of each completed course from the testing edge of a 10 foot (3 m) rolling straightedge by more than 1/4 inch (6 mm). Furnish straightedges, straightedges equipped with levels, or other devices such as approved profilers conforming to Supplement 1058 and using ProVAL software. Obtain the Engineer's approval of the equipment used.

For base courses, do not vary the surface of each completed course from the testing edge of a 10-foot (3 m) straightedge by more than 3/8 inches (10 mm). If using Asphalt Concrete Base as a subbase for a rigid pavement or base, do not exceed a variation of 1/4 inch (6 mm). Furnish straightedges, straightedges equipped with levels, or other devices satisfactory to the Engineer.

Check the surface of each course placed for variations in slope or surface exceeding the tolerances and at locations of suspected bumps when directed by the Engineer.

Correct variations in excess of slope or surface tolerance by removing mixture to neat lines and replacing, or by surface grinding in a manner satisfactory to the Engineer.

401.11 Opening to Traffic. Do not allow traffic, including construction traffic, on the compacted mixture until it has cooled sufficiently to prevent damage. Remove and replace, or otherwise correct in a manner satisfactory to the Engineer, any portion of the pavement course found to be defective in surface texture or composition regardless of whether the defect was identified before or after opening to traffic.

401.12 Method of Measurement. The asphalt concrete pavement thickness shown on the plans or stated in the Proposal is for calculating the weight required to be placed per unit of surface area. The Contractor is responsible for recording the net weight of each truckload of mixture to the nearest 100 pounds (50 kg) in triplicate on plant ticket forms approved by the Department. If the pay quantities are established by platform scales, provide a tare weight for each truck at the beginning of each day's operation and a minimum of every 4 hours of operation each day. The Engineer may require additional tare weight measurements at any time. The Engineer will have the right to monitor all weighing operations and may require reweighing trucks at any time or location. Correct any discrepancies immediately. Continued non-compliance will result in the Department taking necessary and appropriate action, such as, but not limited to, assigning a Department ticket writer to the plant. Send one copy of the plant ticket with each load delivered to the paver and present it to the Engineer.

The Engineer will convert the total of the weights recorded on the plant tickets representing mixture finished according to contract requirements to cubic yards (cubic meters) using a conversion factor established by OMM. OMM will establish this conversion factor from the approved JMF.

If a uniform course is specified, the Department will not pay for cubic yards (cubic meters) that exceed the quantity calculated from plan lines and dimensions.

ITEM 402 ASPHALT CONCRETE MIXING PLANTS

402.01 Description. This specification consists of the minimum requirements for an asphalt concrete mixing plant, including approval, calibration, RAP and RAS management, Warm Mix Asphalt methods, polymer binders, loading and hauling, and mixing and production to produce asphalt concrete mixes according to Department specifications.

Control all production processes at the asphalt concrete mixing plant such that the mixture delivered to the paving site meets all specification requirements.

402.02 Mixing Plants. The Department will approve mixing plants before preparation of the mixtures. Schedule a date with the Department for approval inspection to take place at least 1 week before mix production. Do not produce mixtures for projects from un-approved plants.

Asphalt mixtures may be produced using the warm mix asphalt method according to 402.05 except as restricted by specification.

Store and introduce additives into the plant according to Supplement 1053. Obtain Department approval of the additive storage and feed systems before the start of production.

402.03 Calibration. Ensure the plant is calibrated according to Supplement 1101 when producing any asphalt concrete for the Department.

Before producing asphalt concrete for the Department, demonstrate to the Monitoring Team that the plant adequately meets the specification requirements. Calibrate the plant using procedures approved by the Department. Perform initial calibrations in the presence of the Monitoring Team. District Testing may request a letter of certification and certified data documenting the calibration results, instead of having the Monitoring Team present.

Verify the calibrations biweekly using a Quick Calibration. District Testing may request additional Quick Calibrations if there are mix production problems or plant operation concerns. If the difference between current calibration and the Quick Calibration is within □2 percent, then the current calibration is acceptable. If the 2 percent variation is exceeded, perform a recalibration of the plant. Document the Quick Calibration procedure as specified in the QCP and post the procedure and results in plain view in the plant control room and plant laboratory for reference by the Monitoring Team. Document all data from calibrations in a format approved by OMM, and retain the data for review by the Monitoring Team.

If asphalt concrete is being produced from a batch type plant, verify the accuracy of the aggregate and asphalt binder weighing devices on a biweekly basis. Document the verification procedure as specified in the QCP and post the procedure and results in plain view in the plant control room and plant laboratory for reference by the Monitoring Team. Do not allow the deviation between the plant recorded weights and actual weights to exceed 1 percent. Record all data from verification of weighing devices in a format approved by OMM, and retain the data for review by the Monitoring Team.

Calibrate the asphalt binder meter according to Supplement 1101 Method A or B. When calibrating the asphalt binder meter according to Method B, perform daily aggregate and RAP weighbridge validations. Document which plants follow Method

B in the Quality Control Program (403.03). If issues persist for Method B calibrations or documentation, the Department will require the plant to follow Method A. When performing a complete calibration for ODOT projects notify District Testing 48 hours in advance of the calibration.

402.04 RAP and RAS Processing Requirements. Process and use RAP by one of the following two methods.

A. RAP Processing Method 1-Standard RAP. For surface courses process RAP to less than 0.75 inches (19 mm) and place a 0.75-inch (19 mm) screen on the cold feed. For other courses place a 2-inch (50 mm) screen on the cold feed. Ensure that the RAP is the proper size to allow for complete breakdown in the plant. If mixing is incomplete, place a smaller screen on the cold feed.

B. RAP Processing Method 2-Extended RAP. Use Method 2 only with counter flow drum plants or mini-drum batch plant configurations meeting 402. Process RAP by means of fractionation or by additional in line processing. Fractionate RAP from one pile into multiple piles of various sieve sizes by processing over specific screens as specified in the approved Quality Control Plan. Typically, fractionated RAP is sized into two (coarse or fine) or three (oversize, coarse, or fine) piles. Test fractionated piles to show uniformity. For additional in line processing only process RAP from a uniform, tested and approved stockpile by passing the RAP over a double deck screen placed in-line between the RAP cold feed bin and the mixer. Use a 9/16-inch (14.3 mm) screen for surface and intermediate mixes and a 1.5-inch (37.5 mm) screen for base mixes. Do not use concurrent project RAP in a stream process.

C. RAS Processing and Usage. Ensure RAS is processed to have 100 percent passing the 1/2-inch (12.5 mm) sieve and at least 90 percent passing the No. 4 (4.75 mm) sieve. Ensure RAS has less than 1.0 percent deleterious materials and 0.1 percent metals by weight. Do not blend RAS from manufacturing waste and RAS from roofing tear-offs.

Introduce and control RAS in asphalt plants in the same manner as RAP is introduced and controlled. RAS for base courses may be preblended with RAP if using rate control equipment to ensure uniformity of blending and if satisfactory blend and production is achieved. RAS may be preblended with a small amount of virgin aggregate meeting 703.05 to minimize stockpile agglomeration. Other methods must be approved by OMM.

D. RAP and RAS QC and Management Requirements. Provide enough space for meeting all RAP and RAS handling requirements at a hot mix facility. Provide a clean, graded base for stockpiles that does not collect water. Test blended RAP and RAS stockpiles to assure uniform gradation and asphalt binder content.

If desired, when applying Method 1 Standard RAP requirements, use concurrent Department project RAP in a stream process in place of stockpiling and testing for uniformity but do so in the following manner. Concurrent project RAP must be taken from one existing mix type on the concurrent project or two existing mix types if both mix types are taken at the same time in one pass of the milling machine. If these requirements are not met, blend and test for uniformity and apply the stockpile requirements of this specification.

Maintain in the plant lab and control room an up to date and dated site map of all tested and untested RAP and RAS stockpiles. Give each stockpile a unique identification and identify if RAS piles are from un-used manufactured shingle waste or used roofing tear-off shingles. Provide in the plant lab RAP and RAS properties for each uniform, blended stockpile cross referenced with its identification. In addition, provide the date the stockpile processing was completed and the stockpile estimated size in tons. Provide signage at all RAP and RAS piles. Do not add to a stockpile once it is tested for uniformity. Provide signage at all uniform stockpiles to inform haulers that uniform piles are not to be added to.

Stockpiles and processing methods are subject to inspection and approval by the Department at any time. Rejection of stockpiles can occur for the presence of foreign or deleterious materials, lack of uniformity, incomplete mixing in the asphalt mixture, adding to piles, or moving RAP or RAS in a way not traceable through the QCP records and methods. OMM will resolve disputes over acceptability of RAP or RAS.

402.05 Warm Mix Asphalt. Warm Mix Asphalt (WMA) is defined as asphalt mixtures produced with various technologies, including water foaming and chemical additives, that have the capacity to be used with lower production temperatures (below 300 degree F), but can also be used at normal production temperatures to achieve improved compactability, in-place density, and sustainability and without a diminution of short- and long-term performance. WMA technologies may be used to produce asphalt concrete. Specify the use of warm mix asphalt in the QCP for approval by OMM. Notify District Testing before using and ensure the daily TE-199 Quality Control Report reports that WMA was used during production.

A. Water Injection System. Use a water injection system approved by OMM for the purpose of foaming the asphalt binder. Only use equipment that has been proven stable and effective through project use on non-ODOT projects. Ensure equipment for water injection meets the following requirements:

1. Injection equipment computer controls are in the plant control room and are tied to the plant computer metering.

2. Injection equipment has variable water injection control controlled by the plant operation rate and the water injection can never exceed 2.2 percent by weight of asphalt binder.

3. Water injection rate cannot be manually overridden by the plant operator once in the computer.

4. Injection equipment stops water flow when a control or equipment failure in the injection system occurs.

5. The water injects into the asphalt binder flow before the asphalt binder spray hits aggregate. Do not allow water to touch aggregate before the binder spray.

6. Injection equipment includes water storage and pump control tied to the injection computer controls.

7. Water storage low water alarm installed in the control room.

8. Provide a PG binder sampling valve between the last piping tee on the tank side of the line and the injection equipment to sample PG binder before water is injected.

B. Other WMA Technologies. All other WMA methods or technologies will be reviewed by OMM for approval.

Chemical WMA may be used where WMA is allowed. Use chemical WMA additives on the approved list only. When chemical WMA is required by specifications, in-line blend according to Supplement 1053, Method A and produce mix using HMA mixing temperatures when producing for cold temperature paving. Ensure injection equipment for in-line blending meets the requirements of Supplement 1053, Method A when required to in-line blend. When chemical WMA is not required by specifications, the chemical WMA additive may be added in-line blend according to Supplement 1053, added at the asphalt binder terminal, or to the tank at the mix plant. Ensure bill of lading from terminal and TE-199 documents that WMA was used, the amount used, and the product name used.

402.06 Post Blended SBR Polymer Binders. If an asphalt binder is modified by SBR at an asphalt concrete mixing plant, equip the plant with an automated SBR flow control and monitoring system. Obtain OMM's approval of the system before operating, and demonstrate the system calibration to District Testing. If District Testing waives the demonstration, provide a letter documenting calibration data for the flow system to District Testing for each project. Obtain written approval from OMM for the use of SBR and ensure the QCP contains methods for properly controlling and sampling SBR binder blends.

For drum mix plants, introduce the SBR directly into the asphalt binder line through means of an in-line motionless blender or other device approved by OMM that is able to provide a homogeneous blend. Ensure the in-line motionless blender design provides aggressive interaction of asphalt binder and SBR emulsion to provide a homogenous blend at the sampling port. Do not use swirl type blend.

Locate a sampling valve between the in-line blender and the plant drum, at least 12 ft (3 m) downstream of the in-line blender and at least 5 ft (1 m) downstream of a piping elbow. Ensure the sampling valve port is at least 1 inch (25.4 mm) in diameter. Ensure the sampling valve can be opened quickly for maximizing sample flow for the purpose of obtaining a proper sample.

In place of an in-line sampling valve, a sample may be taken from a 3 to 5 gal (11 to 19 L) surge tank as long as the tank is downstream of the required blender and the in-line flow can be quickly and directly diverted to the surge tank.

Continue mixing for a minimum of 20 seconds after SBR is added and long enough to provide a uniform mixture.

Ensure the SBR pumping and metering system is capable of adding the SBR within the limits of 702.01. For drum plants ensure the SBR pump is automatically controlled by an independent computer and interfaced with the asphalt binder flow to automatically maintain the SBR flow within specification limits. Produce asphalt mixtures for placement in automatic SBR control mode only.

Ensure the SBR meter is a magnetic flow meter consisting of a metering flow tube which utilizes Faraday's Law of Induction to measure the flow and includes a transmitter to transmit the flow signal to a totalizer located in the control room of the asphalt plant. Obtain OMM approval for use of any other type of SBR meter. Locate the SBR meter downstream of any recirculation lines. Provide a means for removing the SBR line at the in-line blender to be able to obtain a sample of the SBR for calibration purposes. Ensure the SBR meter is accurate to ± 2.0 percent over a flow range typical of that used at the asphalt plant (typically 0.8 to 12 gpm (0.05 to 0.76 L/s) at drum plants and 10 to 25 gpm (0.63 to 1.58 L/s) at batch plants).

Ensure the totalizer displays total volume measured and flow rate in standard engineering units. Ensure the totalizer is interfaced with a data logger that produces printouts of the logged data every five minutes for a drum plant or every batch for a batch plant. Ensure the logged data includes time, date, flow rate, and flow total except flow rate is not necessary for batch plant production.

402.07 Mixing and Production. Do not start mix production without a preliminary JMF approval and 48 hour notification of District Testing. Do not start each production day without the moisture contents of the aggregate, RAP, and RAS stockpiles to be used in the JMF tested according to 403.06. Ensure the moisture contents are entered into computerized plant controls. Ensure new moisture contents are tested and entered after weather events and as outlined in the Contractor's QCP.

Set the plant controls for the computerized plant at the JMF design total and virgin asphalt binder contents, recycled materials, and any other additives used at all times unless a change is authorized by District Testing. Follow 403.07 for JMF field adjustments.

Maintain the temperature of the mix at the plant within the range in JMF or according to the specification. Ensure the mixture is workable and temperature is sufficient for compaction at the point of placement.

For batch plants, after all of the aggregate is in the mixer, add the asphalt binder in an evenly spread sheet over the full length of the mixer. The mixing time is defined as the interval between the start of application of the asphalt binder and the opening of the mixer gate. Discharge all asphalt binder required for one batch in 30 seconds or less. After the asphalt binder is added, apply the mixing time determined by OMM but not less than 30 seconds.

When using a batch plant for base mix production, use screens with openings of sizes that result in a reasonably balanced separation of the dried and heated aggregate into a minimum of two bins.

A. Aggregate Preparation. Feed aggregates in their proper proportions and at a rate to permit correct and uniform control of heating and drying. Remove all aggregates in the plant that will produce a mix outside the temperature limits or that contain excessive moisture or expanding gases causing foaming in the mixture and return them to the proper stockpiles.

B. Asphalt Binder. Heat the asphalt binder and deliver it to the mixer within the temperature range specified in Table 702.00-1. Do not use asphalt binder while it is foaming in a storage tank.

For drum mix plants, introduce the SBR binder directly into the asphalt binder line as described in 402.06. For batch plants, add the SBR binder after the aggregate has been completely coated with asphalt binder. Continue mixing for a minimum of 20 seconds after SBR is added and long enough to provide a uniform mixture.

Take samples using approved, new, containers from the binder line between the last piping 'tee' and inlet into the plant unless a different storage method requires a different sampling location.

At a minimum, take a split sample of asphalt binder whenever the Department requests a sample.

For sampling SBR binder, the contents of the tank should be drained into a 5 gal (19 L) sampling bucket and stirred before filling the required sample container. Provide a sampling valve port that is in a position to safely obtain the required sample volume in the required 5 gal (19 L) sampling bucket. Provide a stable sampling rack to obtain a sample.

Balling or wadding of SBR or uncoated aggregate indicates improper mixing; cease production immediately and until corrected to District Testing satisfaction.

C. Stopped Production. Do not restart production after a shutdown required by 403 until OMM or District Testing accepts the proposed remedy.

Following a shutdown restart production in a manner acceptable to District Testing. When production problems cannot be solved within one day after a plant shutdown, a Contractor's approved Asphalt Level 3 Technician is required to be at the asphalt plant until a full production day is achieved with results satisfactory to the Monitoring Team as established in 403.06.

402.08 Loading and Hauling. Before loading, apply a thin coating of an approved release agent to the inside surfaces of the truck bed to prevent adhesion of mixture to the bed surfaces. OMM maintains a list of approved release agents. Do not use diesel or fuel oil for this purpose. Any use of non-approved release agent, diesel, or fuel oil may result in suspension of truck, driver, or both for up to one year. Drain truck beds after applying the release agent and before loading.

Load trucks in manner to minimize segregation of the mixture.

Equip all truck beds with a securely fastened, waterproof cover of suitable material to protect the mixture from wind and weather. Cover truck beds with the secure, waterproof cover after loading.

ITEM 403 ASPHALT CONCRETE QUALITY ASSURANCE

403.01 Description. This specification outlines the asphalt concrete quality assurance program including the contractor requirements for controlling asphalt concrete mixtures during production through quality control (QC) testing and the Department Verification Acceptance (VA) program.

403.02 General. The Department will verify quality control by Department VA tests and monitoring reviews as specified. If the Contractor fails to operate according to their Quality Control Program (QCP), the Department will accept asphalt mixtures by Restricted Acceptance.

Restoration of VA procedures will be by the Department's Quality Control Review Group (QC Review Group) based on District recommendation and review of the Contractor problems, resolutions, and QCP. The QC Review Group consists of the Asphalt Materials Engineer, Office of Materials Management; the Administrator, Office of Materials Management; and the Pavement Engineer, Office of Construction Administration.

Acceptance does not relieve the Contractor of responsibility for supplying and installing a finished product conforming to all requirements of the Contract.

Supplement 1041 outlines the responsibilities and requirements for Contractor and Consultant employees engaged in all aspects of asphalt concrete production at any level, including, but not limited to, management, supervision, quality control, plant operations, materials management, paving operations, and hauling truck drivers.

403.03 Quality Control Program (QCP). Create and implement a Quality Control Program (QCP) for each paving season. The QCP will cover processes conducted to provide an asphalt mixture at the paving site that is uniform in composition, conforms to the specification requirements and that when placed is free of any defect (ex. segregation, lack of mixture and texture uniformity, raveling, rutting, holes, debris, etc.) within the Contractor's control at project completion. A minimum of 3 weeks before mix production, but no later than February 28, submit a hard copy of the proposed QCP to OMM for review and acceptance. Include a revision date on the cover sheet and revision sheet listing the date(s), section(s) and page(s) a revision was made, and a short description of what was revised, added, and removed.

Send a hard copy and a digital copy (if available) of the acceptance letter and accepted QCP to District Testing in every District in which work is performed. Keep copies of the letter and the QCP in each Contractor plant laboratory and plant operation control room. Digital copies of the QCP and letter in pdf format are allowed in each Contractor plant laboratory and plant operation control room with the following requirements: The file icon must be appropriately labeled and be on the computer desktop of a computer in each area. Ensure the QCP contains page

numbering and a Table of Contents inside the front cover locating all sections by page number. Remove out-of-date QCPs from the computer desktop.

Failure to comply with the approved QCP may result in removal of personnel in accordance with Supplement 1041, removal from VA, and adversely affect the Contractor's Prequalification rating.

As a minimum include in the program:

A. The assignment of quality control responsibilities. Quality control includes all efforts required to achieve a product meeting specifications. List individuals as required below and note their designated responsibilities to meet QCP requirements. Provide a Quality Control Manager holding a Supplement 1041 Level 3 approval and who is a company employee. Assign Level 2 technicians for all Level 2 QC testing duties, and provide a list designating their responsibilities and expected actions. Ensure only approved personnel handle and test samples at all times. If Level 2 consultant technicians are used, include a document in the QCP listing designated responsibilities and expected actions (if different from employee expectations). Provide a copy of the document to the Level 2 consultant technician. Define who is responsible at plants and specific methods for ensuring haul vehicles meet all requirements and proper bed release products are used. Provide a Field Quality Control Supervisor (FQCS), holding Supplement 1041 Field Quality Control Supervisor approval and who is a company employee, who is routinely and usually at the paving site during placement of any non-temporary asphalt concrete pavement. Ensure personnel obtaining and handling cores at the project site are approved Level 2 technicians, FQCS or personnel approved by OMM.

B. Means for annual training in ethical conduct according to company expectations of all company employees and consultants who are responsible for the mix design, production, testing, and placement of asphalt mix and their supervisors. Document how and when training is given, what the expectations are, how expectations are communicated and list all personnel trained. Describe the QC Manager's and supervisor's responsibilities and methods in ensuring ethical conduct is maintained throughout the year.

C. Provisions to meet the Department mix specifications. Include an example control chart according to 403.06.E.

D. Procedures for extra testing (e.g., job start, responses to poor test results or field mix problems, aggregate stock testing, reclaimed asphalt concrete pavement checks, moistures) and any other testing necessary to control materials not already defined in these Specifications.

E. Specify warning bands to be used by technicians for all tests and give specific instruction how the warning bands will be used for tests in concert with 403.06.F and Table 403.06.G-1 specification requirements.

F. Methods to maintain all worksheets, including all handwritten records, and other test and sample records from all plant(s) and, or project(s) for a minimum of eight years. Define the test record process. Define company records retention requirements. Provide copies of all test reports and forms used in the quality control process.

G. Procedures for equipment calibration and documentation for Level 2 lab equipment. Provide documentation that all Level 2 lab equipment has been calibrated at the time of the Level 2 lab approval inspection. Procedures for calibration record storage.

H. Method of Quick Calibration and documentation for each plant type.

I. Procedure for random sampling to be used at the plant and documentation method. Procedures for sample taking, tracking, handling and documentation method for all samples taken at the project paving site including taking of all cores used for density determination or density gauge correlation. Include how QC Managers will enforce random number sampling.

J. Procedures for handling and testing of the mix plant asphalt binder QC samples and subsequent corrective action of binder test failures of any sample (QC or Department). Include how samples will be labeled and stored. Failure to perform QC of asphalt binder samples is at the Contractor's risk. Any Department binder sample failures will result in penalties according to Supplement 1102. These include remove and replace, pay deductions, or other penalties for the asphalt mix represented by the Department's sample.

K. All procedures to meet the processing, testing and documentation requirements for RAP and RAS in 402.04 including test forms, record keeping, technician responsibilities, etc. Include the RAP method for each mix plant. Include in the QCP methods of validating RAP properties when using concurrent project RAP. Include additional methods and procedures to dictate how the processing of RAP by means of fractionation or by additional in line processing will be accomplished for mix plants using Method 2. Specify documentation method for RAP measurement. Include RAS usage methods before using RAS and include what Contractor requirements apply to the RAS processor. Include the Contractor's blending equipment type and operation and uniformity testing requirements for preblended RAP and RAS or RAS and virgin aggregate. Other methods must be approved by OMM.

L. Procedure for ensuring that every Contractor employee involved in the testing of asphalt mix and operation of the asphalt plant facility has read the QCP and has on site access to all applicable Department specifications, proposals, policies, and the current approved JMF.

M. Procedure for ensuring asphalt binder Bills of Lading with BOL load number, binder source and grade are reviewed against running JMFs and record of review listing the above information be kept in the plant lab for the duration of the project. Means to meet the handling and storage requirements of 402.06 and asphalt binder suppliers for all asphalt binders.

N. Means to meet delivered mixture uniformity/coating and hauling/trucking requirements.

O. Define the roles and responsibilities of the Field Quality Control Supervisors. Provide a detailed description of how the FQCS will handle all mat issues including segregation, tenderness, mat tears, debris, holes, etc. List approved Field Quality Control Supervisors.

P. Include a section for how the quality control, production and placement of SMA will meet 443, if the contractor plans to produce and place SMA.

Q. Specify the use of Warm Mix Asphalt (WMA) including water-injection or other WMA technologies per 402.05. Include an explanation of what WMA technology will be used at each facility and how it'll be incorporated into the mix.

R. Signature of the Quality Assurance Manager and, if different, the person in authority to enforce all operations covered by the QCP as outlined in this subsection.

403.04 Testing Facilities. Provide testing facilities at the plant site conforming to Supplement 1041.

403.05 Asphalt Mixture Sampling. Sample enough material to perform all required testing. Follow sampling requirements as outlined below.

Quality Control Sampling. For quality control testing, the Contractor's technician will randomly select the truck in which to take a sample by using a random number procedure as outlined in the QCP. The Contractor's technician will give no indication to anyone of the time that the sample is to be taken. Include the random number, sample tonnage location, and time of sampling on the daily Quality Control Report (Contractor form TE-199) with each test.

Sample for quality control tests a minimum of one time for each 700 tons (635 metric tons), or for any portion of 700 tons, of asphalt concrete produced, for every production day. A production day includes the period of time from when mix production begins to the time the last load of asphalt leaves the asphalt plant, either from the mix drum or from any storage silo. Any planned break in plant production to accommodate a new work shift triggers a new production day. Perform more sampling and testing than the minimum specified at the start of production. Tests, other than the required random sample tests, are at the Contractor's discretion according to the QCP but do need to be reported on TE-199 and declared as an extra sample.

Provide a clean area of sufficient size and a hard surface to perform sample splitting at the testing facility. Split samples by quartering and recombining only as described in AASHTO R 76, Method B for hard surfaces for the Department and Contractor's sample. Alternately, use a mechanical splitter per AASHTO R 47 meeting Type A followed by the quartering method. The split sample size required is generally 22 to 27 pounds (10,000 to 12,000 g). A mechanical quartering device approved by OMM may be used in lieu of the above but only split according to the procedure outlined in the Contractor QCP. Ensure that every quality control or 448 Sublot sample taken by the technician has a labeled split for the Department. Wrap and label split samples as to Lot or Sublot, time, location (tonnage), and accompanying Contractor test identification. The Monitoring Team will pick up all Department split samples within 4 workdays. Sample mishandling (careless identification, changing sample size, consistency, or pre-testing) will result in a change to Restricted Acceptance.

For 448 and 449 acceptance mixes not including 301, 302, and Type A mixes, conform to the procedures of Supplements 1035, 1038, 1039, and 1043. The District may require sampling from the road. Lots will be 3000 tons (3000 metric tons), and Sublots will be 750 tons (750 metric tons). However, when production is limited to

less than 3000 tons (3000 metric tons), consider the quantity produced as a partial Lot. For partial Lots of 1500 tons (1500 metric tons) or less sample and test at least two sublot samples regardless of the tons produced. Split and test all sublot samples taken by the Contractor from locations selected by the Monitoring Team or Engineer. The Contractor may test a QC sample at the required Sublot sample location as both a QC and Sublot test provided the sample is tested for all required quality control properties. Test results will apply for both QC and sublot requirements. A change in the location of the Sublot sample must be approved by the Monitoring Team and be reasonably close to the original location. This allowance does not apply to any other samples including Department VA sample locations selected by the Monitor. Label Department split samples as Sublot or quality control samples.

Perform additional sampling per 403.11 if mix plant facility is under restricted acceptance.

403.06 Quality Control Tests. Prior to each production day, determine the moisture content of each aggregate, RAP, and RAS stockpile to be used in the JMF according to AASHTO T 255 and ensure the moisture contents are entered into the mix plant controls. Retest stockpiles after weather event prior to resuming production day and as outlined in the Contractor's QCP.

Perform quality control tests on all samples to control the asphalt concrete mix within the specifications. As required by mix type, ensure that these quality control tests measure the asphalt binder content, gradation, air voids, and Maximum Specific Gravity (MSG) according to the Contractor's QCP. Perform only asphalt binder content and gradation for 301, 302, and 424 Type A.

Additionally, perform more sampling and testing than the minimum during production when the quality control tests show the asphalt concrete being produced is outside the warning bands as shown in the Contractor's QCP. Immediately resolve problems indicated by any test result exceeding the warning bands and immediately retest to validate corrections have returned the materials to within the warning band limits. The Contractor may determine the method of testing of the asphalt concrete beyond the minimum specified and will detail the methods technicians will follow in the Contractor's QCP.

Should additional testing as required above not be performed, District Testing, after consultation with OMM, will require the testing frequency to be increased for the remainder of the project. If this occurs, District Testing will request an opinion from the QC Review Group for action(s) against the technician and/or Contractor including but not limited to warning, removal and/or a change of the facility to Restricted Acceptance.

Record the results of every test performed.

Perform the required quality control tests, control charts, and test requirement as follows:

A. Asphalt Binder Content. Determine the asphalt binder content of a sample of asphalt concrete by performing an Asphalt Content (AC) Gauge test according to Supplement 1043. Make all printouts available for review by the Monitoring Team

at any time. Offset the AC Gauge for each JMF on each project at the project's start. Perform the offset using the solvent extraction method for every QC sample according to Supplement 1038 and the AC Gauge Verification and Offset Record until the offset is established. Use solvent extraction according to Supplement 1038 when an AC Gauge problem exists and for testing cooled samples that cannot adequately be tested in an AC Gauge test.

Total, for each day's production, the flow meter printouts for SBR polymer added at the asphalt concrete mixing plant. Calculate the percent of polymer versus neat asphalt binder in the mix each day and record on the TE-199. Hold calculation worksheets and printouts in the plant laboratory for review by the Monitoring Team. A +/- 0.2 percent tolerance from the target amount of SBR polymer will be used as a guide for an acceptable amount of SBR polymer, but consistently low will not be acceptable. Only take SBR PG-Modified Binder samples using a five-gallon (19 L) bucket. Take 1 gallon (4 L) to clean the valve port and discard. Take 2 gallons (7.5 L) again, stir its contents and transfer to the required sample containers.

Determine the moisture content of the asphalt concrete for each AC Gauge test according to Supplement 1043. Maintain the moisture content at 0.8 percent or less.

B. Gradation. Perform the gradation test on aggregate remaining after removing the asphalt binder with a solvent from an asphalt concrete sample used in an AC Gauge test (solvent sample) or on aggregate remaining after removing the asphalt binder with a preapproved asphalt ignition oven according to Supplement 1054 and from an asphalt concrete sample used in an AC Gauge test (ignition oven sample). Use only an asphalt ignition oven to obtain an aggregate sample from an asphalt concrete sample having a polymer modified PG Binder. District Testing may make an exception to this for SBS polymer as long as no issues arise. Correct each solvent sample for ash. Perform all other gradations on solvent samples, ignition oven samples, or on samples obtained according to the Contractor's QCP.

The gradation results of all the sieves must be representative of the JMF. If the Contractor fails to control the entire gradation, the Laboratory may require a redesign according to 440.

When the F-T value is specified for a mix, calculate it for each gradation analysis. Maintain the F-T value at +4 percentage points or less for these mixes during production.

Calculate the F/A ratio for every solvent sample or ignition oven sample analysis. Maintain the F/A ratio so no F/A ratio is greater than 1.2 for all mixes. Use the asphalt binder content determined by the AC Gauge for calculating the F/A ratio. If the F/A ratio is greater than 1.0, recalculate the F/A ratio using the effective asphalt binder content. Calculate the effective asphalt binder content on the calculation sheet using the asphalt binder content determined by the AC Gauge and attach it to the Quality Control Report. Use bulk and effective aggregate specific gravities and remaining values needed in the calculation from the approved JMF. Do not deviate from these values without OMMs approval. If the F/A ratio is greater than 1.0 for ignition oven samples, calculate the F/A ratio using the percent passing the No. 200 (75 μm) sieve from a washed gradation of the ignition oven sample according to AASHTO T 30.

C. Air Voids and MSG. Determine the air voids of the asphalt concrete by analyzing a set of compacted specimens and a corresponding MSG determination according to Supplement 1036. Use a Marshall or gyratory compactor meeting the requirements of Supplement 1041 to compact specimens. If the compactor was moved to the plant before production, calibrate it and present the results to District Testing. Ensure that the cure temperature and specimen compaction temperature are the same. Use a 1-hour cure for all mix samples used in voids analysis. The Contractor may use a 2-hour cure time if voids are consistently near the low void warning band. In this case, use the 2-hour cure for all voids testing through the remainder of the project. Use the JMF lab compaction temperature. Do not reduce lab compaction temperature for warm mix asphalt. Use a compaction temperature tolerance of +/- 5.0 ºF (3.0 ºC). Compact specimens to design blows or Ndes. Record on the TE-199 if the mixture produced was ran at the asphalt plant as a hot mix asphalt (HMA) or as a warm mix asphalt (WMA) produced according to 402.05 or another approved method.

Calculate the Voids in Mineral Aggregate (VMA) value for every set of compacted specimens according to Supplement 1037.

Calculate the average of all the MSG determinations performed each production day and report this average on the Quality Control Report. When the range of three consecutive daily average MSG determinations is equal to or less than 0.020, average these three average MSG determinations to determine the Maximum Theoretical Density (MTD). After the MTD is established, compare all individual MSG determinations to the MTD.

D. Other Requirements. Perform a APA test once each day for the first 3 days according to Supplement 1057 if the produced mixture requires an APA test. Compact the sample the same day the sample was taken, cure it overnight, and test it the following day. Give the test result and sample density to District Testing the day of the APA test. Report the APA data on the Quality Control Report.

Retain a split sample for each AC Gauge test and MSG test and all compacted specimens for monitoring by the Department. Maintain MSG samples in the state described in AASHTO T 209, Section 7.3 and keep sample at room temperature. The Contractor may dispose of the AC Gauge test samples after two days and all other split samples after seven days if the Department does not process the split samples.

Measure the temperature of the mixture and record. Validate the results on the load tickets at least once during each hour of production.

The Contractor may conduct additional testing of any type. Record such additional testing along with all other quality control records and have these records readily available for the Monitoring Team's review. District Testing may observe, review, and approve or disapprove the procedures at any time.

E. Control Charts. Maintain up to date control charts showing each individual test result and the moving accumulative range as follows all mixes:

1. Plot tests showing the percent passing for the 1/2 inch (12.5 mm), No. 4 (4.75 mm), No. 8 (2.36 mm), and No. 200 (75 µm) sieves, the percent asphalt binder content, the MSG, and the percent air voids. Round all percentages to the nearest whole percent; except, round asphalt binder content, the No. 200 (75 µm) sieve, and air voids to the nearest 0.1 percent.

2. Show the out of specification limits specified in 403.06.F and Table 403.06.G-1 and QCP Warning Band Limits on the control charts.

3. Label each control chart to identify the project, mix type and producer.

4. Record the moving accumulative range for three tests under each test point on the chart for air voids and asphalt binder content. Accumulative range is defined as the positive total of the individual ranges of two consecutive tests in three consecutive tests regardless of the up or down direction tests take. If more than the minimum required testing (i.e. 700 tons per sample per production day, 403.05.A) is performed do not include the result in accumulative range calculations

F. Test Requirements for 301, 302, and 424 Type A. Control mixes as follows:

1. If a single asphalt binder content is more than □0.5 percent beyond the JMF, immediately take and test an additional sample.

2. If the Range difference in any three consecutive asphalt binder content tests is greater than 0.7 percent (for 302 mix) or 0.6 percent (other than 302) immediately notify the Monitoring Team.

3. If the Range difference in any three consecutive gradation tests for the No. 4 (4.75 mm) sieve is greater than 10.0 percent, immediately notify the Monitoring Team.

4. Maintain gradations within design limits of mix type.

5. Maintain a minimum of 7 percent retained on the 1 inch (25.0 mm), ¾ inch (19.0 mm), ½ inch (12.5 mm), and 3/8 inch (9.5 mm) for 302 mix.

Stop production and immediately notify the Monitoring Team when either 6 or 7 occurs:

6. If two consecutive asphalt binder content tests are more than ± 0.5 percent beyond the JMF, notify the Monitoring Team and cease production until the problem is corrected.

7. If Range deviations as specified in 2 or 3 continue, cease production. Range is defined as the difference between the largest and the smallest test result.

Any mixture sent to the paving site without stopping production and notifying the Monitoring Team, when required by this specification, will be considered non-specification material.

G. Test Requirements for all other mixes. Control all other mixes of Table 403.06.G-1 and as follows:

TABLE 403.06.G-1

Mix Characteristic	Out of Specification Limits[5]
Asphalt Binder Content[1]	-0.3% to 0.3%
1/2 inch (12.5 mm) sieve[1]	-6.0% to 6.0%
No. 4 (4.75 mm) sieve[1][8]	-5.0% to 5.0%
No. 8 (2.36 mm) sieve[1]	-4.0% to 4.0%
No. 200 (75 µm) sieve[1]	-2.0% to 2.0%
Air Voids[2]	2.5% to 4.5%
Air Voids[3]	3.0% to 5.0%
MSG[4]	-0.012 to 0.012
F/A	1.2 max
F-T	+4 max[6]
VMA	[7]

[1] Deviation from the JMF
[2] For Design Air Voids of 3.5%
[3] For Design Air Voids of 4.0%
[4] Deviation from the MTD
[5] Unless otherwise restricted by mix type specification
[6] When specified for mix type
[7] Not to exceed minimum requirements of mix type
[8] For 442 12.5 mm mixes do not exceed 63% max during production

Stop production and immediately notify the Monitoring Team when either 1, 2, or 3 occurs:

1. Any two tests in a row or any two tests in two days are outside of the specification limits of Table 403.06.G-1.

2 Any two tests in a row or any two tests in two days (QC and 448 sublot) exceeding 63 percent passing the No. 4 sieve for 442 12.5 mm mixes.

3 Any four consecutive moving accumulative ranges greater than specification limits of 2.50 percent for air voids or 0.60 percent for asphalt binder content occur.

Any mixture sent to the paving site without stopping production and notifying the Monitoring Team, when required by this specification, will be considered non-specification material.

H. Restart of Production. Do not restart production until an adequate correction to remedy problems is in place and the Monitoring Team is satisfied. Following a shutdown restart production in a manner acceptable to District Testing. When production problems cannot be solved within one day after a plant shut down a Contractor's representative holding Level 3 Asphalt Department approval is required to be at the asphalt plant until a full production day is achieved with results satisfactory to the Monitoring Team.

403.07 JMF Field Adjustments. During the first three days of production the Contractor may adjust the JMF gradation within the below limits without a redesign of the mixture. For projects with less than 3 days of production, give District Testing written notice of any JMF gradation adjustments within 1 workday following the last day of production. Limit adjustments of the JMF to conform to actual production, without a redesign of the mixture, to ±3 percent passing each of the 1/2 inch (12.5 mm), No. 4 (4.75 mm), and No. 8 (2.36 mm) sieves and ±1 percent passing the No. 200 (75μm) sieve. Do not exceed the limits in Table 424.03-1, Table 441.02-1, Table 442.02-2, and Table 443.03-1 in the adjusted JMF. The adjustment on the 1/2-inch (12.5 mm) sieve applies to 19.0 mm and Type 2 mixes only. Determine the need for any JMF gradation adjustments in the time specified. Should no adjustments be made, the Department will base acceptance on conformance to the original JMF. After the time period specified, the Department will allow no further adjustment of the JMF.

Should a redesign of the mixture become necessary, submit a new JMF according to the requirements for the initial JMF. A new acceptance lot will begin when a new JMF established by a redesign of the mixture becomes effective. Make any adjustment of this new JMF as provided for the original JMF. Record both the design JMF and the adjusted JMF in effect during production of an acceptance lot on the Quality Control Report for that lot. In the event that a new JMF is proposed and approved, also make a notation on the ticket for the first load produced under the new JMF.

403.08 Quality Control Reports. Use Contractor Form TE-199 for the Quality Control Report. Record all test results and sample identification on the Quality Control Report including the random number, sample tonnage location, and time of sampling with each test. Record on the TE-199 if the mixture produced was ran at the asphalt plant as a hot mix asphalt (HMA) or as a warm mix asphalt (WMA) produced according to 402.05 or another approved method. Also record if antistrip additives were used and the daily quantity used. After startup adjustments, report any plant operation changes on the Quality Control Report. Ensure that each Quality Control Report contains technician comments as to production quality, input materials received and condition, and includes any other quality control activities as specified in the QCP. Document all decisions regarding responses to test results on the Quality Control Report (referring to the particular test), including reasons why a particular problem may exist, what action was taken to correct the problem (plant operation or testing), and what communication with Department personnel took place. Attach computerized plant printouts representing samples tested to that day's report, if desired by the Monitoring Team, or otherwise keep them with the quality control records. Ensure that the technician records the test results for the AC content and percent passing the No. 4 (4.75 mm) sieve on the plant printout from the tonnage the quality control sample was taken. Keep remaining printouts in the plant laboratory for the duration of the project. Keep a copy of all quality control reports for a project in the Contractor's plant laboratory.

Deliver (fax, e-mail, hand) completed Quality Control Reports to District Testing by the end of each day in which testing is conducted. If desired by District Testing and always for unsigned E-mail versions, mail the originals. Ongoing problems with

inadequate, incomplete, or illegible reporting will result in a change to Restricted Acceptance. The Contractor's technician must sign each Quality Control Report. Retain copies of all records documenting the quality control inspections and tests as outlined in the Contractor's QCP per 403.03.F and furnish them to District Testing on request.

Provide delivery tickets of liquid or hydrated lime antistrip additive, if used, to District Testing at the end of the project and at the end of each construction year on a multiple year project. Provide the following information for each shipment: Letter of certification, Production date, Shipment date, Shipment destination, Batch or lot number and Net weight. The District Testing will verify the number of pounds of antistrip additive used is within 10 percent of the calculated amount of antistrip additive required for the total weight of asphalt binder, based on the JMF, used in the asphalt concrete. The Department may obtain samples of the hydrated lime at any time to verify quality. If the quality of the hydrated lime is in question, the Department may require independent laboratory testing.

Report test results to the accuracy of the following decimal places. When the figures to be dropped in rounding off are exactly one-half of unity in the decimal place to be retained, round the value up to the nearest number in the decimal place to be retained.

TABLE 403.08-1 REPORTING ACCURACY

	Single Test	Average
Asphalt Binder Content	0.01	0.1
No. 200 (75 μm) sieve	0.1	0.1
Other sieves	Whole number	Whole number
BSG, MSG, MTD	0.001	0.001
Air Voids	0.1	0.1
VMA	0.1	0.1
F/A	0.1	0.1
F-T	Whole number	Whole number
Mix Moisture Percent	0.01	0.01
LWT, inch (mm)	0.0004 (0.01)	0.004 (0.1)

Additionally for 448 and 449 acceptance mixes (excluding 301, 302, and 424 Type A), track the 448 Sublot and Lot tonnages through the project and identify on the Quality Control Report each random Sublot test as to Lot number and Sublot tonnage location. In addition to the Quality Control Report submit the TE-448 Department form with lot identification and actual sieve weights for each Sublot sample from the technician's gradation worksheets.

403.09 Mixture Deficiencies. Control all production processes to assure the Engineer that the mixture delivered to the paving site is uniform in composition; within the specification requirements and limits; conforms to the JMF: and that the placed mixture is free of any defect (ex. segregation, tenderness, lack of mixture and/or texture uniformity, raveling, flushing, rutting, holes, debris etc.) within the Contractor's control. Correct obvious pavement problems according to 401.08. If the Department has any suspicion that other mixture composition or pavement

problems exist, the Monitoring Team will conduct an initial investigation through review of data and/or sampling of the asphalt pavement. Should a Department investigation determine that the Contractor's QCP is not controlling the mixture in a manner to achieve mixture quality as described above, the Contractor quality control data may be rejected. In that case the Department will conduct a thorough investigation by testing samples from the roadway and use those test results in determining disposition of the non-specification material.

A mixture is not uniform in composition if multiple random non-specification individual tests or any four consecutive non-specification moving accumulative ranges exist. The mixture can be rejected, production can be stopped and/or a redesign can be called for by the Department. OMM will not approve any redesign it determines is unsatisfactory to provide acceptable mix performance. Submit this new design for approval according to 440 and at no additional cost to the Department.

When any out of specification material, based on quality control tests not within the limits of 403.06.F and Table 403.06.G-1, is sent to the paving site the Engineer will determine disposition of the material according to Supplement 1102.

403.10 Verification Acceptance (VA). District Testing will perform VA by testing independent and split samples. If the random Department VA sampling and testing verifies the accompanying Contractor tests, the average of the Contractor's quality control tests for each day or night (for 449 acceptance mixes according to 449.04.A), the average of the Contractor's tests for each Lot (for 448 acceptance mixes according to 448.04) or daily average MSG (446, 447, 448, or 449 acceptance mixes other than 301, 302, and 424 Type A) will be used to determine acceptance.

A. Monitoring. The Department will establish District Monitoring Teams for the purpose of verifying all Contractor mixture production processes. Verification may be accomplished by obtaining split samples from Contractor QC or independent samples from the plant or roadway. If independent samples are taken split them for Contractor testing.

B. Sampling. District Testing will perform the VA by testing independent and split samples. The Department may take Daily samples for verification of plant operation.

For 446, 447, 448, and 449 acceptance mixes other than 301, 302, and 424 Type A the MSG VA testing will be performed by District Testing on a minimum of one in every four required District sampled Daily samples. Other properties can be tested for by the District as desired.

C. Department Verification Testing and Monitoring. For 446, 447, 448, and 449 acceptance mixes the Monitor will randomly choose one Department sample in a maximum of every four production days for VA testing to confirm Contractor testing and mix control. The Department can require samples from the project site (hopper, plate or truck). More frequent VA samples can be taken when desired. The Department VA sample location will be chosen randomly by the Monitor, including where to take the sample, if applicable. The Contractor technician will take the sample with the Monitor witnessing. The Monitor will keep the sample in the Department's possession until delivered to District Testing or testing is complete.

The Monitor will have enough sample taken to split with the Contractor. The Monitor will split the sample in the Contractor lab. The Monitor will have the sample tested at District Testing or as noted below. The Contractor will test the split of the VA sample with the Monitor witnessing. The Department will use its VA test result, the Contractor result of the split, as well as the most recent previous day (or night) Contractor quality control and/or sublot test in the comparison for the Department VA testing.

The Monitor may opt to test the Department VA sample in the plant laboratory with the Contractor's permission, according to the Contractor's safety practices, and with the restriction of only the Contractor's technician physically placing a sample pan in the AC Gauge. However, if the Monitor tests VA samples on Contractor equipment, test a VA sample on District Testing equipment a minimum of one time in 15 production days from a given plant regardless of the number of projects or JMFs tested in the Level 2 lab. Record the results and testing location in the District Testing project record. One day may be added to the above Department sample testing frequency for each day production is less than 500 tons (450 metric tons).

For 446, 447, 448, and 449 acceptance mixes other than 301, 302, and 424 Type A the MSG VA testing will be performed by District Testing a minimum of one in every four days. The MSG VA may also include the District-sampled Daily samples, 448 sublot samples, or samples split with the Contractor at the plant. The MSG VA result will be compared to that days Contractor average of MSG QC test results. Any MSG split sample results will be compared with the Contractor split result.

For all mixes, the District may increase the number of VA testing samples if desired.

All Department VA test results will be given to the Contractor by a reasonable arrangement acceptable to both. Department VA sample testing not completed in a timely manner is of no value in verifying quality control testing quality for Contractor test acceptance and/or investigating problem causes. As such, if not completed in a timely manner, Contractor tests will automatically stand and the District will note the problem in the District's VA record.

TABLE 403.10-1 DEPARTMENT VERIFICATION ACCEPTANCE AND QUALITY CONTROL TEST COMPARISON

	Percent Asphalt Binder		**Percent Passing No. 4 (4.75mm)**		**MSG Comparison**
	VA [1]	**QC/lot test** [2]	**VA** [1]	**QC/lot test** [2]	**VA** [3]
301, 302, 424 Type A	±0.3	±0.4	±4.0	±5.0	
446, 447, 448, rest of 449 mixes	±0.3	±0.3	±4.0	±4.0	0.010

[1] District VA mix test deviation from Contractor split and from the approved JMF. For Basic mixes, use the tolerances in Table 403.06-2 when comparing District VA to JMF.
[2] District VA mix test deviation from most recent previous day (or night) QC and/or lot test.
[3] Deviation of District MSG VA compared to QC MSG daily average.

If the Department VA tests confirm Contractor testing is within the verification tolerances, but a pattern of high or low results exist that suggests mix control is not at the JMF, then investigate with the Monitoring Team's assistance to correct the problem to the Monitoring Team's satisfaction. Direct any questions regarding interpretation of circumstances to OMM.

D. Contractor Tests are Verified. Production is acceptable if:

1. The Monitoring Team verifies the Contractor's QCP is being fully followed; and

2. The Department VA tests are within the limits specified in 403.10.C; and

3. For 301, 302, and 424 Type A mixes, the remaining sieves do not exceed the limits of the applicable specification.

Failure on the Contractor's part to respond and resolve Monitoring Team concerns may result in a change to Restricted Acceptance.

Acceptance is per 446, 447, 448, or 449.

E. Contractor Tests Not Verified. If the Department VA test does not verify the accompanying Contractor tests within the verification tolerances, then the Monitoring Team will investigate. If the Department MSG VA test shows the MSG comparison tolerance in Table 403.10-1 is not met, a single Department tested MSG for that day and every prior production day back to when the Department MSG VA last met the tolerance will be used for each 446, 447, 448, or 449 acceptance mixes other than 301, 302, and 424 Type A Day/Lot density and QC air void determination.

If the deviation between the District and Contractor test is greater than the limits in Table 403.10-2 immediately cease production until resolved. If the deviation is less than the limits in Table 403.10-2 and discrepancies continue, perform additional tests to aid in problem solving.

TABLE 403.10-2 DEVIATION LIMITS

Property	Mix	Limits
Asphalt Binder Content	All	±0.5 %
No. 4 (4.75 mm) sieve	All, except 302	±6.0%
	302	±7.0%

The Contractor may request a review with the Department occasionally for the purpose of determining the cause of a comparison problem. Department decisions upon review are final. If a Contractor is requesting a review of every occurrence of lack of comparison and the Department test is always found correct, the Department may deny that Contractor further reviews.

Additional tests may include any testing necessary to resolve the problem. If the additional testing does not resolve the problem by one-half production day or

1000 tons (1000 metric tons), whichever occurs first, to the Monitoring Team's satisfaction, stop production, if not already, until problems are resolved. Contact OMM for assistance in resolving problems. If the District testing program is confirmed by the additional tests and Monitoring Team investigation and no reason to question the original test exists, then the original District VA tests will stand.

After the above investigation, one of the three following actions will occur:

1. Mix Production Compares Well to the JMF. If the District test and investigation shows mix is actually controlled well compared to the JMF in spite of the Contractor test, the District does not have to test additional samples if the Contractor testing problem is corrected.

2. Mix Production Does Not Compare Well to the JMF. If the District tests and investigation shows lack of Contractor mix control compared to the JMF the District will test the remaining Department split or Daily samples for the days or Lots represented by the original tests. The District will use the test results to calculate the acceptance. While working with the District, immediately take steps to correct the problem according to the QCP. Failure to achieve a quick resolution will result in a change to Restricted Acceptance.

3. District Testing Problem. If the District testing program has a problem as confirmed by the additional testing and District review, the District will correct the problem, throw out the original District test results and take new samples from the samples representing the days or Lots in question for the VA tests.

F. Contractor Department VA Removal and Restoration. For 446 and 447 MSG, for a given Contractor facility, if in a series of 15 or more Contractor/ Department MSG comparison tests (VA, Monitoring tests) the Contractor MSG is lower than the Department MSG by more than 0.002 and occurs a minimum of 65 percent of the time the facility will be removed from Department MSG Verification Acceptance and operate under 403.11. (At a minimum, a report will be issued annually of the Contractor/ Department MSG comparison status of each facility for this determination. This frequency may be increased.)

For all other mixes, if repeated problems with poor comparison of tests are not the District's fault; or poor comparison of Contractor tests to the JMF; or with plant operation, input materials, or any of the other requirements of Department specifications occur in a single project or successive projects, the District will request an opinion from the QC Review Group before notifying the Contractor of removal from Department VA. The District will immediately notify the Contractor of the removal with a follow up letter from District Testing. Once notified, acceptance of asphalt mixtures is by Restricted Acceptance. Restoration of the VA procedures may occur on a future project with a District recommendation to the QC Review Group based on consistent improved plant operation and mix control, a review of the Contractor problems and resolutions, and a review of the QCP by the QC Review Group.

403.11 Restricted Acceptance. If the Contractor is removed from Department VA, the following will occur.

The Contractor must bring its QCP and operation to a level acceptable to the District and QC Review Group before production continues. District Testing will ensure that the project C-95 (Contractor's Prequalification Rating survey) reflects the change to Restricted Acceptance in all of the appropriate C-95 categories. The Department will accept all material for Department projects from the facility under Restricted Acceptance. While the facility is under Restricted Acceptance, acceptance of small quantities under the small quantities policy will not apply.

Quality control testing requirements specified in 403.06 are modified as follows:

A. The required number of test series is a minimum of four each per production day or night. If a production day is less than 6 hours, the Department may reduce the frequency but not less than one test series per every 3 production hours. This requirement does not apply to 446 and 447 MSG as outlined below.

B. For 301, 302, and 424 Type A mixes, if the variation from the JMF for one test is ±8 percent passing the No. 4 (4.75 mm) sieve or ±0.3 percent asphalt binder content, investigate and correct the problem, then resample and test. Maintain the moving average of three tests within ±4 percent passing the No. 4 (4.75 mm) sieve and ±0.2 percent asphalt binder content. In addition to the Quality Control Report, maintain control charts according to 403.06.E for asphalt binder content and the No. 4 (4.75 mm) sieve. If the Range difference in any three consecutive tests is greater than 0.6 percent for asphalt binder content or 10.0 percent passing the No. 4 (4.75 mm) sieve, notify the Monitoring Team. If Range deviations as specified continue, cease production.

For 446 and 447 MSG, the Department will test a single daily MSG for each corresponding 446 and 447 Day/Lot density determination from the facility. The facility can be returned to Department MSG VA when the 65 percent criteria (see 403.10.F) is not exceeded in a series of 30 comparison tests.

C. Report each day's testing on a Quality Control Report, according to 403.08. Report all testing performed by the Contractor's technician on the Quality Control Report. After startup adjustments, report any plant operation changes on the Quality Control Report. Ensure that each Quality Control Report contains technician comments as to production quality, input materials received and condition, and includes any other quality control activities required in the QCP. The Contractor's technician must sign each Quality Control Report. Attach each day's computerized plant printouts to that day's report. The technician must note on the accompanying printout from which tonnage the quality control sample was taken with accompanying test results for asphalt binder content and percent passing the No. 4 (4.75 mm) sieve. Keep a copy of all Quality Control Reports for a project in the Contractor's plant laboratory.

The District will monitor according to 403.10, except notification for ceasing production does not have to be in writing. Additional samples may be obtained for Department testing at any time.

For 301, 302, and 424 Type A mixes, if the average of the Lot or partial Lot acceptance tests for any sieve other than the No. 4 (4.75 mm) sieve exceeds the specification limits, the pay factor is determined as follows:

TABLE 403.11-1 301, 302, 424 TYPE A PAY FACTORS

Number of Tests	1	2	3	4
Pay Factor	0.98	0.97	0.96	0.95

For 448 acceptance mixes, the Department will perform acceptance sampling and testing according to 403.05, 448.04, and 449.04 except the Lot size will be 5000 tons (5000 metric tons) with 1250 ton (1250 metric tons) Sublots. Sublots and acceptance samples may be taken from the roadway or plant at the Districts discretion. Department testing under Restricted Acceptance will receive a lower testing priority than other VA projects.

ITEM 407 TACK COAT

407.01 Description. This work consists of preparing and treating a paved surface with asphalt material, and cover aggregate if required.

407.02 Materials. Conform to the applicable requirements of 702 for the asphalt material and use one of the following types: 702.04 RS-1, SS-1, SS-1h, CRS-1, CSS-1, or CSS-1h; 702.12 Non-Tracking Asphalt Emulsion or 702.13 SBR Asphalt Emulsion.

Supply 702.12 Non-Tracking Asphalt Emulsion any time Item 407 Non-Tracking Tack Coat is specified.

Conform to 703.06 for cover aggregate.

407.03 Equipment. Provide adequate cleaning equipment, spreader boxes, and distributors.

Use distributors designed, equipped, maintained, and operated to apply asphalt material at the specified rate per square yard (square meter) with uniform pressure over the required width of application. Ensure that the distributor includes a tachometer, pressure gauges, and an accurate volume measuring device or a calibrated tank. Mount an accurate thermometer with a range covering the specified application temperature for asphalt material at approximately center height of the tank with the stem extending into the asphalt material. Ensure that the distributor has a full-circulating system with a spray bar that is adjustable laterally and vertically. Ensure that the spray bar will maintain a constant height above the pavement under variable load conditions. Supply each distributor with suitable charts showing truck and pump speeds and other pertinent application data necessary to obtain the required results.

Do not use equipment that cannot obtain the correct tack application.

407.04 Weather Limitations. Do not apply the asphalt material if the surface temperature is below the minimum placement temperature for the pavement course to be placed, as specified in 401.05.

407.05 Preparation of Surface. Ensure that the surface is thoroughly clean and dry when the asphalt material is applied. Remove material cleaned from the surface and dispose of it as the Engineer directs.

407.06 Application of Asphalt Material. Uniformly apply the asphalt material with a distributor having clean nozzles functioning properly.

For irregular areas such as driveways and intersections, apply the asphalt material using a method the Engineer approves.

If paving asphalt concrete directly onto Portland cement concrete or brick pavement, tack the pavement with SBR asphalt emulsion conforming to 702.13.

Apply the asphalt material in a manner that offers the least inconvenience to traffic. Only apply the asphalt material to areas that will be covered by a pavement course during the same day. Ensure the tack breaks before releasing to construction traffic unless the paver is equipped with a spray bar system to apply tack just prior to mat placement.

Apply asphalt material to obtain uniform coverage within the range specified in Table 407.06-1, as directed by the Engineer. Obtain the Engineer's approval for the quantity, rate of application, temperature, and areas to be treated before application of the asphalt material. The Engineer will determine the actual application in gallons per square yard (liters per square meter) by a check on the project.

TABLE 407.06-1, TYPICAL TACK COAT APPLICATION RATES

Existing Pavement	Application Rate gal/yd^2 (L/m^2)
New Asphalt	0.05 to 0.06 (0.23 to 0.27)
Oxidized Asphalt	0.08 to 0.09 (0.36 to 0.41)
Milled Asphalt Surface	0.08 to 0.09 (0.36 to 0.41)
Milled PCC Surface	0.06 to 0.08 (0.27 to 0.36)
PCC Surface	0.06 to 0.08 (0.27 to 0.36)

The application is considered satisfactory when the actual rate is within ±10 percent of the required rate and the material is applied uniformly with no visible evidence of streaking, ridging or pickup by construction traffic. The Engineer will require proper correction when ridging, streaking, pickup or other non-uniform coverage is observed. Correct non-uniform tack only in areas of non-uniform

coverage. Do not reapply tack in areas where the tack meets uniformity and application requirements.

If the coverage is not uniform and not corrected the total square yardage of non-uniform application will be considered non-specification material. The Engineer will determine the number of gallons (liters) for non-payment by using the approved rate of application times the total square yards (square meters) of non-uniform application.

407.07 Method of Measurement. The Department will measure Tack Coat and Non-Tracking Tack Coat by the number of gallons (liters) of undiluted asphalt material applied for each according to Item 109.

407.08 Basis of Payment. The cost of cover aggregate is incidental to Tack Coat.

The Department will not pay for non-uniformly applied materials as defined in 407.06.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
407	Gallon (Liter)	Tack Coat
407	Gallon (Liter)	Non-Tracking Tack Coat

ITEM 408 PRIME COAT

408.01 Description. This work consists of preparing and treating an existing surface with asphalt material, and cover aggregate if required.

408.02 Asphalt Material. Conform to the applicable requirements of 702 for asphalt material and use one of the following types: 702.02 MC-30, MC-70, or MC-250; or 702.03 Primer 20.

408.03 Cover Aggregate. Use cover aggregate conforming to No. 9 size or gradation requirements of 703.05 or 703.06.

408.04 Weather Limitations. Do not apply asphalt material on a wet surface. Do not apply prime coats for asphalt concrete or surface treatment work when the atmospheric temperature is below 50 °F (10 °C) or when the air temperature within the preceding 24 hours has been 40 °F (5 °C) or lower. Do not apply prime coats on

stabilized or granular base courses when the atmospheric temperature is below 40 °F (5 °C).

408.05 Equipment. Use equipment conforming to 407.03.

408.06 Preparation of Surface. Shape the surface to be primed to the required grade and section. Ensure the surface is free from all ruts, corrugations, segregated material or other irregularities and is smooth and uniformly compacted at the time of application of the asphalt material. Clean the surface in a manner that will thoroughly remove all mud, earth, and other foreign material. Take care to clean the edges of road to be primed to ensure uniform application of the asphalt material directly onto the existing base or pavement surface. Remove material cleaned from the surface and dispose of it as the Engineer directs.

408.07 Application of Asphalt Material. Apply asphalt material in a uniform manner spread to the width of the section to be primed by means of a distributor conforming to 407.03. Take care that the application of asphalt material at the junction of spreads is not in excess of the specified amount. Squeegee excess asphalt material from the surface. Correct skipped areas or deficiencies.

Do not allow traffic on the prime coat until the asphalt material has been absorbed by the surface and will not be picked up. Obtain the Engineer's approval for the quantity, rate of application, temperatures and areas to be treated before application of the prime coat.

408.08 Application of Cover Aggregate. If, after applying the prime coat, the asphalt material fails to penetrate and traffic must use the roadway, spread cover aggregate in the amount required to absorb any excess asphalt material.

408.09 Method of Measurement. The Department will measure Prime Coat by the number of gallons (liters) according to 109.

408.10 Basis of Payment. The cost of cover aggregate is incidental to Prime Coat.

The Department will pay for accepted quantities, complete in place, at the contract price as follows:

Item	Unit	Description
408	Gallon (Liter)	Prime Coat

ITEM 409 SAWING AND SEALING ASPHALT CONCRETE PAVEMENT JOINTS

409.01 Description. This work consists of saw cutting and sealing the finished surface of the asphalt concrete pavement and shoulders directly over and in line with transverse joints in the underlying Portland cement concrete pavement.

409.02 Materials. Use joint sealant conforming to 705.04 and approved by OMM before shipment to the project. Use a 1/2 inch (13 mm) diameter closed cell foam backer rod that will form and maintain a reservoir of sealant as specified in 409.03.

409.03 Construction Details. Saw cut, clean, and seal transverse joints as a continuous operation. If the surface course is not placed within 5 days after the intermediate course is placed, make a 1/8-inch (3 mm) wide saw cut that is one-fourth the depth of the intermediate course over contraction joints and a 1/2-inch (13 mm) wide cut that is one-fourth the depth of the intermediate course over expansion joints.

Saw joints in the surface course as soon as the saw can be operated without damaging the asphalt concrete, but no later than 48 hours after the asphalt concrete is placed.

Locate the sawed joints directly over each transverse pavement joint in the concrete pavement, including joints at full-depth pavement repairs. Accurately locate joints with pins or stakes before paving. Pre-mark the saw cut on the new asphalt with a chalk line or other acceptable method. Obtain the Engineer's approval of the method for locating and accurately marking the proposed saw cuts before starting any resurfacing operations.

Saw all transverse joints and create a joint sealant reservoir according to Table 409.03-1. Use either dry or wet cutting. Make one or two passes to create the saw cut and joint sealant reservoir.

TABLE 409.03-1

Measurement	Inch (mm)
Saw cut depth	2 (50)
Backer rod diameter	1/2 (13)
Joint sealant reservoir	
Width	3/8 (10)
Depth	3/4 (19)
Recess below surface course	1/8 (3)

Clean dry sawed joints with compressed air to remove dirt, dust, or deleterious matter. Use an air compressor with a minimum rated capacity of 100 pounds per square inch (689 kPa) and sufficient hose for continuous cleaning operations.

Clean wet sawed joints with a water blast to remove sawing slurry, dirt, or deleterious matter. Dry wet sawed joints with a propane torch or lance unit capable of producing a blast of hot air at 2000 °F (1093 °C) and with a gas velocity of 2000 feet per second (610 m/s).

Extend the transverse saw cut joints the full width of the asphalt over the concrete pavement and paved shoulders.

Do not allow traffic to knead together or damage the sawed joints before sealing.

Heat joint sealant material in a kettle or melter constructed as a double boiler, with the space between the inner and outer shells filled with oil or other heat transfer medium. Provide positive temperature control and mechanical agitation.

Heat the material according to the manufacturer's recommendation. Consider the first gallon (4 L) of material that flows out of the applicator wand at the start of the day spoil, and discard it into a container so designated.

After cleaning, place the backer rod in the sawed joints, then immediately seal the joints with sealant applied through a nozzle projected into the sawed joint, filling from the bottom up. Ensure that the sealant completely fills the joint such that after cooling, the level of the sealant is below the surface by less than 1/8 inch (3 mm). Fill any depression in the seal greater than 3/16 inch (5 mm) to the specified limit by adding additional sealant. Do not overfill the joints. Take care in the sealing of the joints so that the final appearance will present a neat line.

409.04 Method of Measurement. The Department will measure Sawing and Sealing Asphalt Concrete Pavement Joints by the number of feet (meters) of joints sawed and sealed.

409.05 Basis of Payment. The Department will not pay for saw cuts in the intermediate course.

The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
409	Foot (Meter)	Sawing and Sealing Asphalt Concrete Pavement Joints

ITEM 410 TRAFFIC COMPACTED SURFACE

410.01 Description. This work consists of furnishing and placing an aggregate wearing course on the completed and accepted subgrade or temporary road.

410.02 Materials. Furnish materials conforming to 703.18 for the type of material specified (Type A, Type B, or Type C).

410.03 Conditioning of the Subgrade. Eliminate wavy and irregular surfaces and maintain the subgrade in this condition until the application of material under this item. If the subgrade is soft due to rain, frost, or snow, place material only as permitted.

410.04 Spreading and Shaping. Uniformly spread the material using an approved spreader box or by other methods. Spread the amount of material shown

on the plans or as directed by the Engineer. After spreading, blade and shape the materials to the specified cross-sections. Haul the material to its place on the road over the previously spread material. Conduct the hauling to obtain uniform compaction over the entire width of the surface material without rolling.

410.05 Maintaining. After shaping the material, blade it as directed by the Engineer. Open the road to traffic immediately after all the material has been spread and shaped.

Correct all holes, ruts, defects, or soft places that occur in the subgrade or surface by adding material and dragging. Maintain the surface, slopes, shoulders, ditches, and drainage structures until the work on this item has been completed and accepted.

410.06 Method of Measurement. The Department will measure Traffic Compacted Surface, Type ___ by the number of cubic yards or tons of accepted material placed, shaped, and maintained as specified.

The Department will measure the cubic yards of aggregate used loose in the vehicle at the point of delivery or calculate it by converting from weight using the following conversion factors:

TABLE 410.06-1

Material	Conversion Factor
Gravel, bank run or crusher run	2700 lb/yd³
Limestone, crusher run	2500 lb/yd³
Gravel, Size No. 4 and 57	2500 lb/yd³
Limestone, Size No. 4 and 57	2400 lb/yd³
Crushed slag [1]	
less than 80 lb/ft³	2000 lb/yd³
80 to 90 lb/ft³	2100 lb/yd³
90.1 to 100 lb/ft³	2300 lb/yd³
100.1 to 125 lb/ft³	2700 lb/yd³
more than 125 lb/ft³	3000 lb/yd³
Recycled Portland Cement Concrete	2250 lb/yd³
Reclaimed Asphalt Pavement	2650 lb/yd³

[1] Based on average dry rodded weight determined by the Laboratory. The conversion factors listed are the long gradation weights. These numbers are based on the dry rodded weights of Nos. 67, 57, or 8 gradation. The Department will determine slag weights based on weights obtained from the original source.

The Department will classify salvaged or mixed materials according to the material that makes up the majority of the mixture.

Ensure that the moistures of the delivered material are less than 2 percent above saturated surface dry condition; if not, the Department will base payment on the dry densities and dry weights.

Furnish freight bills, and weight and volume evidence according to 109.

410.07 Basis of Payment. The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
410	Cubic Yard or Ton	Traffic Compacted Surface, Type A or B
410	Cubic Yard or Ton	Traffic Compacted Surface, Type C

ITEM 411 STABILIZED CRUSHED AGGREGATE

411.01 Description. This work consists of placing a compacted course or courses of crushed aggregate.

411.02 Materials. Furnish materials conforming to 703.18.

411.03 Construction Methods. Construct the subgrade according to Item 204. Use the spreading and compaction requirements of Item 304, except as modified by the following:

A. Use a maximum compacted lift thickness of 6 inches.

B. Perform the initial compaction of the material by using crawler type tractors, tamping rollers, trench rollers, suitable pneumatic tire equipment, or other suitable equipment.

C. Perform final compaction of the surface of the stabilized crushed aggregate by using approved pneumatic tire equipment.

Unless otherwise specified in the Contract Documents, the Engineer will perform all compaction tests according to Supplement 1015.

411.04 Method of Measurement. The Department will measure Stabilized Crushed Aggregate by the number of cubic yards computed from the profile grade, cross-sections and typical sections, compacted in place.

When the plans provide for the use of material in variable width or depth of course and the quantity cannot be readily calculated from the profile grade, typical sections and cross-sections, the Department will measure the cubic yards by converting from weight using the following conversion factors:

TABLE 411.04-1

Material	Conversion Factor
Crushed stone	3800 lb/yd³
Crushed gravel	3900 lb/yd³
Crushed slag [1]	
less than 90 lb/ft³	3600 lb/yd³
90 to 100 lb/ft³	4000 lb/yd³
more than 100 lb/ft³	4500 lb/yd³
Granulated slag	2800 lb/yd³
Recycled Portland Cement Concrete	3400 lb/yd³
Reclaimed Asphalt Pavement	4000 lb/yd³

[1] Based on average dry rodded weight of standard size of slag aggregates on record at the Laboratory. The conversion factors listed are the long gradation weights. These numbers are based on the dry rodded weights of Nos. 67, 57, or 8 gradation. The Department will determine slag weights based on weights obtained from the original source.

The Department will classify salvaged or mixed materials according to the material that makes up the majority of the mixture.

Ensure that the moistures of the delivered material are less than 2 percent above saturated surface dry condition; if not, the Department will base payment on the dry densities and dry weights.

Furnish freight bills or certified weight bills according to 109.

411.05 Basis of Payment. The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
411	Cubic Yard	Stabilized Crushed Aggregate

ITEM 421 MICROSURFACING

421.16 Basis of Payment

421.01 Description. This work consists of constructing a cold laid polymer modified emulsified asphalt pavement course to fill ruts or provide a leveling and/or surface course for existing pavements. Warrant the microsurfacing for two years.

421.02 Materials. Furnish materials conforming to:

Emulsified Asphalt (Binder)..... 702.16, Type C
Aggregate..... 703.01, 703.05
Water 499.02
Mineral Filler (Portland Cement)..... 701.04
Tack Coat 421.09

Use a quick-traffic polymer modified emulsified asphalt binder (Binder) conforming to 702.16, type C. Use only Binder certified according to Supplement 1032. Provide to the Engineer certified test data and a statement from the Binder supplier with each load of Binder that the Binder is the same base asphalt binder, polymer, polymer percentage as formulated and used in the mix design. Include the percent residue on the Bill of Lading.

Conform to 703.01 and 703.05 for aggregate, except as follows:

TABLE 421.02-1

Percent by weight of fractured pieces	100
Sand Equivalence (AASHTO T176)	55 minimum

Do not use aggregates designated with “SR” or “SRH.”

Provide an aggregate blend of 50 percent crushed carbonate stone (CCS) and 50 percent igneous diabase (ex. Ontario Trap Rock) for Surface Course (FR). Provide CCS aggregates for all other microsurfacing courses.

Provide a final blend of aggregates that conform to Table 421.02-2 Gradation A for the aggregate for surface courses, Gradation B for the aggregate for rut fill courses, and Gradation A or B for the aggregate for leveling courses. Stockpile tolerance will be based on target gradation stated in the mix design but will not exceed design gradation band for No. 200 sieve.

TABLE 421.02-2

Sieve Size		Total Percent Passing		Stockpile Tolerance
		A	B	
3/8 inch	(9.50 mm)	100	100	
No. 4	(4.75 mm)	85 to 100	70 to 90	± 5.0%
No. 8	(2.36 mm)	50 to 80	45 to 70	± 5.0%
No. 16	(1.18 mm)	40 to 65	28 to 50	± 5.0%
No. 30	(600 µm)	25 to 45	19 to 34	± 5.0%
No. 50	(300 µm)	13 to 25	12 to 25	± 4.0%
No. 100	(150 µm)	–	7 to 18	± 3.0%
No. 200	(75 µm)	5 to 15	5 to 18	± 2.0%

Screen the aggregate for oversize material prior to use using a 3/8 inch (9.5 mm) screen size. When a blend of aggregates is to be used to meet gradation A or B, proportion the aggregates in a separate stockpile and blend to a uniform consistency prior to screening. Screen the aggregate to complete the blending process and to remove any oversize material prior to use. If oversize material becomes present in the mixture, screen the aggregate directly into material support units.

For mineral filler, use Supplement 1028 Certified Portland cement conforming to ASTM C 150, Type I. Adjustments in the quantity of mineral filler added to the mixture are permitted to improve mixture consistency, mix time, or set time. Do not exceed ± 0.5% from the mix design during placement.

Use water conforming to 499.02. Add water to the mixture to control mixture consistency only and not to control mix time.

Use mix set additives as stated in the mix design to control the mixture's mix and set time. If mix set additives are used during production of mixture, include as part of the mix design. Ensure additives are compatible with the other components of the mix.

421.03 Proportioning. Develop a mix design to comply with the mix design criteria and submit to OMM on approved forms, at least two weeks prior to the start of calibration, for preliminary JMF approval. OMM may require additional time prior for preliminary approval to perform tests on lab materials to ensure mix compliance. OMM will notify the Contractor if additional time for testing is required. Final JMF approval will be granted upon successful placement in the field. OMM may require the Contractor to design and submit for a new JMF for lack of mix compliance or lack of field performance.

Submit the mix design and proposed materials to OMM. Include a minimum of 11 pounds (5,000 g) of each aggregate, one quart (1 L) sample of Binder, 3.5 ounces (100 g) of mineral filler, and one pint (0.5 L) of additive, if used, and a complete mix design packet prepared by an AASHTO-accredited laboratory in Pavement Preservation. Prepare the mix design for gradations A or B and present all test data for all tests specified in Table 421.03-1. Determine the residual binder content and present related proportioning of total water (includes moisture in aggregate), mineral

filler, and additive with tolerances for each in the final designed mixture. Verify during the mix design the compatibility of the aggregate, Binder, mineral filler, and other additives. Produce the mix design using the same materials that will be used on the project. Approved JMF's expire on December 31st.

A. Ensure that the mix design:

1. Has aggregate meeting the gradation specified.

2. Has residual asphalt by dry weight of aggregate of 7.5 to 8.5 percent for leveling and surface courses or 6.5 to 8.0 percent for rut fill courses.

3. Has a mineral filler content of 0.3 to 2.5 percent by dry weight of aggregate and a tolerance of not greater than ± 0.5 percent of the mix design within the required minimum and maximum.

4. Has mix times and wet cohesion requirements based on specific minimum and maximum percent mineral filler, total water, and additive.

5. Has a total water content with a tolerance not greater than ± 1.5 percent.

6. Has a total non-diluted additive content with a tolerance not greater than ± 0.2 percent. Verify that the additive dilution rate with water specified in the mix design is consistent with the paving machine being used.

7. Meets the specified properties of the following International Slurry Seal Association (ISSA) tests:

TABLE 421.03-1

ISSA Test No.	Description	Specification
TB-139	Wet Cohesion	
	30 minutes min. (set time)	12 kg-cm min.
	60 minutes min. (traffic)	20 kg-cm min or near spin
TB-114	Wet Stripping	90 percent min.
TB-100	Wet Track Abrasion Loss 1-hour soak 6 day soak	 450 g/m² max. 650 g/m² max.
TB-144	Saturated Abrasion Compatibility	 2 g loss max.
TB-113	Mix Time @ 25 °C	Controllable to 120 seconds
	Mix Time @ 40 °C	Controllable to 45 seconds
TB-147	Lateral Displacement (For Leveling and Rut Fill courses only)	5%, max.
TB-109	Excess Asphalt by LWT Sand Adhesion	538 g/m² max.

Check the ISSA TB-139 (set time) and ISSA TB-113 (mix time) tests at the highest and lowest temperatures expected during construction.

B. Report the following in the mix design (all percentages are based on the dry weight of the aggregate):

1. Source and location of each individual material. Provide percentage of each aggregate source if multiple aggregate sources are used.

2. Aggregate gradation, washed and dry (dry for field QC). Provide aggregate gradation of each source and final combined if multiple sources are used.

3. Sand equivalence of the aggregate.

4. Percentage of mineral filler and tolerance.

5. Percentage of total water and tolerance and acceptable pH range.

6. Percentage and Type of mix set additives (if required) and tolerance.

7. Percentage of Binder and residual asphalt content in the mixture.

8. Quantitative effects of moisture content on the unit weight of the aggregate per AASHTO T 19 from 0.0 to 10.0% moisture content.

421.04 Quality Control Program (QCP). Create and implement a Quality Control Program (QCP) for each construction season. The QCP will cover processes conducted to provide a microsurface mixture at the project site that is uniform in composition, conforms to the specification requirements and project mix design, and that when placed is free of any defects (lack of mixing, inconsistent texture, inconsistent profile, excessive overlap at joints, streaking, drag marks, roughness, raveling, rutting, holes, and debris, etc.) within the Contractor's control at project completion. Submit a hard copy of the proposed QCP to OMM for review and acceptance. Submit by February 28 or a minimum of five (5) weeks before calibration. Include a revision date on the cover sheet and revision sheet listing the date(s), what section(s) and page(s) a revision was made, and a short description of what was revised, added, or removed.

Submit a hard copy and a digital copy (if available) of the QCP acceptance letter and accepted QCP to District Testing a minimum of two weeks prior to calibration. Keep copies of the letter and the QCP with each Contractor's Quality Control Manager and provide a copy of both to the Engineer. Digital copies of the QCP and letter in pdf format are allowed with the following requirements: The file icon must be appropriately labeled and be on the computer desktop. The QCP must contain page numbering and a Table of Contents inside the front cover locating all sections by page number and out of date QCPs must be removed from the computer desktop.

Failure to comply with the approved QCP may result in work stoppage and adversely affect the Contractor's Prequalification rating.

The QCP is a reflection of a Contractor's sincerity and ability in producing a quality product. Development of this program beyond the minimum requirements specified below is encouraged.

Include in the program:

A. The assignment of quality control responsibilities. Quality control includes all efforts required to achieve a product meeting specifications. List individuals as required below and note their designated responsibilities to meet QCP requirements. Provide a Quality Control Manager who is a company employee who is routinely and usually at the paving site during placement of any microsurfacing. Provide a list

designating technician responsibilities and expected actions. Ensure only trained personnel handle and test samples at all times. Define who is responsible at the project site and specific methods for ensuring mixing equipment, haul vehicles, etc. meet requirements.

B. Means for annual training of company and consultant technicians and their supervisors in ethical conduct according to company expectations. Document how and when training is given, what the expectations are, how expectations are communicated, and list all personnel trained. Describe the QC Manager's and technician supervisor's responsibilities and methods in ensuring ethical conduct is maintained throughout the year.

C. Provisions to meet the Department mix specifications including warning bands and action plans for aggregate, Binder, and tack coat materials to ensure they meet Department testing.

D. Procedures for extra testing (e.g., job start, responses to poor test results or field mix problems, aggregate stock testing, moistures) and any other testing necessary to control materials not already defined in these Specifications.

E. Methods to maintain all worksheets, including all handwritten records, and other test and sample records from the project for the duration of the contract or eight years, whichever is longer. Define the test record process. Define company records retention requirements. Provide copies of all test reports and forms used in the quality control process.

F. Procedures for calibration and documentation for all testing equipment. Procedures for calibration record storage. Procedure to supply documentation records of testing equipment calibration at the request of the engineer.

G. Method of performing mixing equipment calibrations including scales to be used, yield checks, and documentation for each project.

H. Procedure for random sampling to be used at the project and documentation method. Procedures for sample taking, tracking, handling, and documentation method for all samples taken at the project paving site.

I. Procedure for ensuring that every Contractor employee involved in the testing of aggregates and microsurfacing mix and operation of the mixing equipment has read the QCP and has on site access to all applicable Department specifications, proposals, policies, and the current approved JMF.

J. Procedure for ensuring binder Bills of Lading with BOL load number, binder source and grade, and binder percent residue are reviewed against running mix designs and record of review listing the above information be kept with the QC Manager for the duration of the project. Means to meet the handling and storage requirements of the Binder and tack coat suppliers.

K. Means to meet placed mixture uniformity and hauling/trucking requirements.

L. Define the roles and responsibilities of the QC Manager.

M. Signature of the Quality Control Manager and, if different, the person in authority to enforce all operations covered by the QCP as outlined in this subsection.

421.05 Weather Limitations. Apply the mixture only when it is not raining, pavement has no standing water, and the existing pavement surface and atmospheric temperature is a minimum of 45 °F (7 °C) and rising and there is no forecast of an atmospheric temperature below 32 °F (0 °C) within 24 hours from the time the mixture is applied. Between September 30 and May 1, do not apply the mixture if the existing pavement surface temperature is less than 50 °F (10 °C).

421.06 Mixing Equipment. Produce the mixture in a self-propelled, front feed, continuous loading mixing machine equipped with a conveyer belt aggregate delivery system and an interconnected positive displacement, water jacketed asphalt emulsion gear pump to accurately proportion aggregate and asphalt emulsion or a variable displacement computerized rate control to accurately proportion aggregate and asphalt emulsion. Locate the mineral filler feed so the proper amount of mineral filler is dropped on the aggregate before discharge into the pugmill. Provide a spray bar to completely prewet the aggregate dropping into the pugmill with additive and water before introduction of asphalt emulsion. Ensure that the twin-shaft, multi-blade pugmill is a continuous flow type and minimum of 49 inches (1.25 m) long. Ensure that the blade size and side clearances meet the equipment manufacturer's recommendations. Introduce the emulsion within the first one-third of the mixer length to ensure proper mixing of all materials before exit from the pugmill.

Equip the machine with opposite side driving stations to allow full control of the machine from either side. Equip the mixer with a remote forward speed control at the back mixing platform so the operator controlling the mixture placement can control forward speed and level of mixture in the spreader or rut box. Provide material control devices that are readily accessible and positioned so the amount of each material used can be determined at any time.

Equip the mixing machine with a water pressure system and nozzle type spray bar to provide a water spray ahead of and outside the spreader box when required. Apply water at a rate that will dampen the surface, but will not create free flowing water ahead of the spreader box.

The Contractor may use truck-mounted batch machines with a conveyer belt aggregate delivery system and without the front feed, continuous loading feature on projects of less than 15,500 square yards (13,000 m^2), on spot repairs, on projects with multiple routes where every route is less than 15,500 square yards (13,000 m^2), or where specified in the plans.

421.07 Equipment Calibration. Before mix production, calibrate the mixing equipment to the approved JMF in the presence of the Engineer according to Supplement 1040. Verify that the project calibration is not affected by any previous calibrations and scale factors by removing or resetting prior to starting a new calibration. Generate documentation for the Engineer, including individual calibrations of each material at various settings. Perform a calibration for each JMF used on the project. Following calibration, do not make any further calibration adjustments to the mixing equipment without the Engineer's approval. The Engineer may require additional calibrations following any equipment break down related to the aggregate delivery belt, asphalt emulsion gear pump, or mixture performance issues.

Submit the approved mix design information and JMF(s) to the Engineer and District Testing at least 48 hours prior to start of calibration.

421.08 Spreading Equipment. If a leveling or surface course is specified, apply the mixture by means of a conventional spreader box attached to the mixer.

If a rut fill course is specified, apply the mixture with a 5 to 6 foot (1.5 m to 1.8 m) width V-shaped rut filling spreader box attached to the mixer. Equip the rut filling spreader box with a steel strike-off.

If a leveling course is specified, apply the mixture with a spreader box equipped with a steel or rubber strike-off that is designed to fill wheel path ruts. A secondary strike-off may be used to reduce roughness of the leveling course but will not remove mixture in wheel path ruts or affect desired cross section.

Equip the spreader box with paddles or augers mounted on an adjustable shaft to continually agitate and distribute the materials throughout the box. Ensure that the equipment provides sufficient turbulence to prevent the mix from setting in the rut fill or spreader box or causing excessive side build-up or lumps. To prevent loss of the mixture from the spreader box, attach flexible seals, front and rear, in contact with the road. Operate the spreading equipment in such a manner as to prevent the loss of the mixture on superelevated curves.

For surface courses, attach a secondary strike-off to the spreader and adjust as required to provide a uniform mixture texture.

The Contractor may use burlap drags or other drags, if necessary, to obtain the desired finish. Replace drags having excessive build-up.

421.09 Surface Preparation. Before applying the mixture, thoroughly clean the surface.

Remove raised pavement markers according to 621.08, when specified.

Remove all existing pavement markings so that less than 5% of the line remains visible. Repair damage to the pavement that results in the removal of more than 1/8 inch of pavement thickness. When a grinder drum is mounted to a skid steer loader, the drum must be able to accommodate a minimum of 150 teeth.

Seal visible joints and cracks longer than 2 feet (600 mm) in length and any joint or crack greater than 1/4 inch (6 mm) in width no matter the length using Item 423 Type II only. Apply crack sealant material at a width of 2 to 4 inches (50 to 100 mm) and at a thickness of not less than 1/16 inch (2 mm) and not greater than 3/16 inch (5 mm).

Apply a tack coat to the existing pavement surface conforming to 702.16, Type C CSS-1hM, consisting of a minimum of 15% asphalt residue achieved by diluting with water. Apply the tack coat at a rate of 0.06 to 0.12 gallons per square yard (0.25 to 0.45 L/m²) that provides uniform coverage without excess run-off and allow tack to break before releasing to construction traffic. Adjust application rate of tack coat based on surface texture and porosity. Apply the tack coat only to areas that will be covered by the microsurface during the same day. Do not apply tack coat on top of a leveling course prior to placing the surface course.

Protect drainage structures, monument boxes, water valve, etc. during material application.

421.10 Test Strip. Construct a continuous 1000 foot (300 m) long by lane width test strip for each approved JMF(s) for the project. The test strip will demonstrate the mix and set time of the material and ability to perform under full traffic. If handwork will be performed on the project, include handwork in the test strip. Construct the test strip at the same time of day or night the full production will be applied. Perform a yield check to ensure the proper spread rate, surface quality requirements and compliance with JMF components are met. Submit results to the Engineer.

The Engineer will evaluate the completed test strip and yield check report after a minimum of 12 hours under traffic, to determine if the mix design and application is acceptable. The Contractor may begin full production after the Engineer accepts the test strip.

If the microsurfacing is being applied between May 1 and October 15, the Department may waive the test strip if the Contractor has constructed a Department accepted test strip during the same time frame with the same materials and JMF(s) and with no documented project performance issues. Provide documentation (Project Number, District, Route, Test Strip Date, Engineer, etc.) and history from the previous test strip(s) and calibration(s) to the Engineer.

421.11 Application. Apply the microsurface mixture to the prepared surface in a manner to fill cracks, shallow potholes, and minor surface irregularities and achieve a uniform textured surface without causing streaking, drag marks, skips, lumps or tears. Carry a sufficient amount of material at all times in all parts of the spreader box to ensure complete and uniform coverage. Avoid overloading of the spreader box. Do not allow lumping, balling, or unmixed aggregate in the spreader box.

When specified, place leveling courses to cover the entire pavement area as specified. Place the leveling course in a manner to maintain or improve the ride quality of the existing pavement. Provide a completed leveling course with no drag marks or tears greater than 1/2 inch (13 mm) wide, 1/4 inch (6 mm) deep, or 12 inches (25 mm) in length. Provide a completed leveling course free of flushing, bleeding, or added roughness. The completed leveling course may exhibit minor raveling upon opening to traffic but will not exhibit any continued raveling after the first four hours of traffic.

When specified, apply rut fill courses in widths from 5 to 6 feet (1.5 to 1.8 m) for each wheel path. Apply enough material to fill the wheel paths without excess crowning (overfilling). An excess crown is defined as 1/8 inch (3 mm) after 24 hours of traffic compaction. If rut depth exceeds 1.0 inches (25 mm), apply rut fill course in multiple courses. Provide a smooth, neat seam where two rut fill passes meet. Take care to restore the designed profile of the pavement cross-section. After compaction by traffic, ensure the completed rut fill does not result in deviations in excess of 1/4 inch (6 mm) as measured across each wheel path using a 6 foot (1.8 m) straight edge. Do not place microsurfacing surface course material until wheel path deviations in excess of 1/4 inch (6 mm) are corrected. Place the rut fill course

in a manner to maintain or improve the ride quality of the existing pavement. Provide a completed rut fill course with no drag marks or tears greater than 1/2 inch (13 mm) wide, 1/4 inch (6 mm) deep, or 12 inches (25 mm) in length. Provide a completed rut fill course free of flushing, bleeding, or added roughness. The completed rut fill course may exhibit minor raveling upon opening to traffic but will not exhibit any continued raveling after the first four hours of traffic.

If a leveling course and a surface course are specified, apply the microsurface mixture at a minimum of 14 pounds per square yard (7.6 kg/m^2) of dry aggregate weight for the leveling course and 18 ± 1 pounds per square yard (9.8 ± 0.5 kg/m^2) of dry aggregate weight for the surface course. Apply the two courses at a minimum combined rate of 32 pounds per square yard (17.4 kg/m^2) of dry aggregate weight.

If a surface course is specified and it is not placed on a microsurfacing leveling course, apply the microsurface mixture at a rate of 22 ± 0.5 pounds per square yard (11.9 ± 0.3 kg/m^2) of dry aggregate weight. Apply the mixture in a manner to produce a uniform surface texture across the entire paving pass.

For leveling and surface courses, provide a smooth, feathered, neat seam of 1 to 3 inches (25 to 75 mm) where two passes meet at the pavement centerline and at edge of shoulder. In variable width pavement sections minimize overlap and feather overlapping pass on to the completed surface. Construct overlaps such that cross slope drainage is maintained. Immediately remove excess material from the ends of each run.

Construct surface courses at a width to cover the outside edges of rut fill and leveling courses. Construct seams at or near edge of lane but do not construct seams in wheel paths. Maintain straight edge lines along curbs and shoulders. Do not allow runoff in these areas. Ensure that lines at intersections are straight.

Use squeegees and lutes using similar material as the secondary strike-off to spread the mixture in areas inaccessible to the spreader box and areas requiring hand spreading. The Contractor may adjust the mix set additive to provide a slower setting time if hand spreading is needed. Do not adjust the water content to adjust the setting time. If hand spreading, pour the mixture in a small windrow along one edge of the surface to be covered and spread it uniformly by a hand squeegee or lute. Provide uniform appearance of the entire surface area regardless of the means used to spread material.

Ensure that the microsurfacing cures at a rate that will permit traffic on the pavement within one hour after application without damaging the pavement surface. However, should the Contractor experience a curing condition that does not allow the opening to traffic within one hour, work out an arrangement agreeable to the Engineer before releasing traffic on the pavement.

If the final surface course is not uniform in texture, free of streaks, drag marks, lumps or tears, stop applying the mixture and take steps to correct the problem. Do not resume work until the Engineer is satisfied the problem has been corrected.

421.12 Quality Control. Use the methods described in this section to control the quality of the mixture and application, and to measure compliance. If any test results or measures of compliance exceed any of the identified quality control tolerances or specification requirements, stop placement and immediately notify the

Engineer and District Testing. Identify the cause of exceeding any of the identified quality control tolerances and document in detail the corrective action necessary to bring the deficiency into compliance. Implement the corrective action and resume work and immediately perform a test or measure to confirm corrective action has resolved the deficiency. If upon resuming work the tolerances are exceeded, stop the work. Present a revised corrective action plan and obtain the Engineer's approval before resuming work. Upon resuming work, immediately perform a test or measure to confirm corrective action has resolved the deficiency.

The Department can obtain samples of materials at any time. Aggregate samples can be taken from sources, on-hand stockpiles, or from the mixing equipment. Work can be stopped and materials and JMF can be rejected on the basis of poor Department test results. If the Department reports non-compliance on any material test, the Department will compare results with the Contractors Quality Control Manager. The Engineer will determine if the tests or compliance measurement has been satisfactory corrected.

Prior to starting placement, verify the pH of the water to be used is within the acceptable range on the JMF. Verify again if source of water changes.

Perform a minimum of four yield checks daily with one occurring within the first 1000 linear feet (300 linear meter) of continuous placement and the last occurring in the last 1000 linear feet (300 linear meter). Perform at least one yield check for each course applied. For cross-overs, driveways, and any other irregular areas, determine yield checks by a means acceptable to the Engineer. Ensure yield checks are a minimum of 500 linear feet (150 linear meter) for continuous loading mixing machines or one full-loaded truck-mounted machine. Ensure yield checks meet and include documentation of compliance for sections 421.03, 421.05, 421.09, 421.11, and 421.13.

A. Binder. Obtain and label a Binder sample from supply tanker and diluted tack coat sample from the distributor truck at the direction of the Engineer and give the samples to the Engineer the same day. Provide and sample the Binder and diluted tack coat in one-quart (1 L) plastic containers with plastic screw tops. Label and retain one sample per each additional day for the Department. Take more samples when requested by the Engineer.

Visually inspect Binder in supply tanker(s) to ensure uniform material with no separation or contamination. Verify temperature of binder and tack coat. Monitor and verify proportioning of asphalt emulsion and water into distributor and proper mixing before use or sampling. Perform a minimum of one Binder and tack coat cook-off each production day to determine the residue content of the Binder and tack coat and verify compliance. If residue content is in warning band or out of compliance provide the Engineer with corrective actions prior to using.

Ensure mixing equipment is set at design asphalt emulsion percentage during production. Do not exceed a tolerance of ± 0.3% residual content from the design residual content or the minimum and maximum content in the microsurface mix due to fluctuation in residual content in the Binder. If tolerance is exceeded, stop production. Correct the issue by correcting the Binder residual content by methods allowed by Supplement 1032 certified supplier or adjust the asphalt emulsion

percent, if approved by the Engineer. Recalibrate the mixing equipment to the new adjusted asphalt emulsion percent to meet the design residual content of the microsurfacing mix for positive displacement mixing equipment.

B. Aggregate. Ensure the aggregate stockpile or final blended aggregate stockpile if two aggregates are used gradation does not vary by more than the stockpile tolerance in Table 421.02-3 compared to the approved JMF and does not exceed the design gradation band for No. 200 (75 μm) sieve. Ensure the percent passing does not change from the high end to the low end of the range for any two consecutive sieves.

Verify the blending and screening of aggregates at the stockpile site and sample the blended and screened aggregate for QC testing. When two aggregates are used, ensure that the 50/50 blend is within 5 percent based on each stockpile gradation and theoretical blend.

Stockpile a minimum of 10 percent of the project aggregate or 200 tons (180 metric tons) of aggregate whichever is less at a staging area. Obtain three (3) aggregate samples from the stockpile and perform gradation testing on each sample according to AASHTO R 90, AASHTO R 76, Supplement 1004 (AASHTO T 11 where required), and moisture content per AASHTO T 255. Use dry gradations for determining the No. 200 (75 μm) sieve. Determine the percent passing for each sieve size listed in Table 421.02-3. Calculate the average of each sieve for all three tests. Ensure the average value for each sieve is within the requirements of Table 421.02-3. Do not begin production if not in compliance with gradation band and stockpile tolerance.

At a minimum test one sample taken from the stockpile randomly during each production day. When two aggregates are used, sample a minimum of one sample from each stockpile and final blended stockpile randomly. Include additional testing when directed to sample and test by the Engineer. The Contractor may perform an additional aggregate test to verify results if first test is not in compliance with stockpile tolerance. Report and track all test results and monitor trends of the aggregate gradation within the stockpile.

Reject aggregate that does not meet the stockpile tolerance in Table 421.02-3 compared to the approved JMF. Do not exceed the design gradation band for No. 200 sieve.

For data collection by the Department, if requested by the Engineer, obtain a mix sample randomly during the day by dragging a tube sampler across material under the mixer but before the spreader box as it moves forward. Obtain a 10 pound (4535 gram) minimum mix sample, put in a suitable plastic container, and provide to the Engineer.

C. Mixture Application. Ensure the Quality Control Manager and trained technicians perform and use the methods described in this section to control quality and measure compliance.

1. Supervise the mixing machine calibration, test strip application, and verify compliance before production begins.

2. Establish with the mix operator restrictive operating limits for use of total mixture water, additive, and mineral filler subject to weather conditions and course applied.

3. Maintain all calibration records and compare calibration results for each project through construction season.

4. Direct all material input settings required to produce mix design compliance.

5. Verify mixture meets required mix time, set time and mix consistency.

6. Perform an aggregate moisture test at the start of each production day.

7. Communicate and direct any desired adjustments with the Binder supplier (asphalt emulsion) for mix and set time properties.

8. Evaluate roadway for determination of planned application rates and maintain direct communication with Department personnel, application personnel, and Engineer on all compliance issues.

9. Verify and document that all cracks greater than 1/4 inch (6 mm) in width and all cracks longer than two feet (50 mm) have been filled and that the crack sealant is in compliance with thickness requirements.

10. Monitor roadway during application for proper surface cleaning.

11. Monitor application of tack coat for proper coverage and document application rate.

12. Monitor mixture placement for consistency, uniformity of thickness across paving pass, and use of water spray bars.

13. Monitor mixture application rate and finishing methods to ensure uniform surface.

14. Monitor cross section compliance subject to course type specified.

15. Monitor set properties for opening to traffic and durability under traffic.

16. Monitor daily production reports for compliance with mix design tolerances.

17. Maintain each material usage by ticket weight and verify consistency to mixing machine calibrated use.

18. Direct adjustments of material settings and mixture subject to material test results and field performance.

19. Monitor haul trucks, mixing machine, and allied equipment for oil drippings, aggregate spillage and other factors that may affect the adherence or performance of the applied mixture.

D. Documentation. Provide the Engineer a daily report no later than the next calendar day (excluding Sundays) with the following:

1. A printout from the mixing machine showing the total pounds of aggregate, emulsion, and cement as well any other materials capable of being printed used for the day as part of the daily production report.

2. Project number, county, and route.

3. Date, air temperature, pavement temperature, and humidity.

4. Binder temperature, percent residue, and pounds per gallon (grams per liter)

5. Production report with course(s) applied, lane(s) completed, location of work, daily summary of each material used, application rate for each course and lane and total area per course.

6. Yield checks on application rate and compliance with application placement requirements (four per day, minimum).

7. Gradation and moisture content (one random sample during the day and any other samples when directed by the Engineer).

8. Total gallons (L) of tack coat used and residual asphalt content.

9. Quality Control Tests and Reports.

10. Contractor representative's signature.

Provide a Bill of Lading for Binder and aggregate as requested or at project completion..

421.13 Acceptance. Maintain continuous control of the Binder to dry aggregate proportioning to conform to the approved JMF(s) within a tolerance of ± 1.5 gallons per ton (±6.3 L/metric ton). Control the spread rate to not less than the specified quantity of aggregate per square yard (square meter) on a dry weight basis.

The Engineer will base acceptance of the binder-to-dry aggregate proportion and spread rate on the Engineer's summary of quantities used each day. The Engineer will approve and accept a day's application of microsurfacing provided:

A. The Engineer's summary indicates conformance with the above control requirements for proportioning and spread rate.

B. The course(s) applied are in compliance with the application requirements of this specification.

C. The pavement cracks are sealed prior to placement of the microsurface.

D. The Quality Control requirements are met.

E. The pavement is uniform in composition and texture, free from excessive scratch marks, tears, rippling and other surface irregularities (segregation, raveling, rutting, holes, debris, etc.), longitudinal joints and lane edges coincide with any lane lines and edge lines and transverse joints are uniform, neat and provide a smooth transition.

The spread rate requirement does not apply to rut fill courses if the Contractor filled the wheel paths according to this specification..

421.14 Performance Review. Perform remedial actions for any defect exceeding the threshold levels in Table 421.14-1 for a period of two years from the date of substantial work complete as documented on the Department's Form C-85. Contact the Department to schedule a final performance review at least 60 days prior to the end performance review period. The Department will review the pavement before the end of the two-year performance review period to determine if remedial action is required. The Department will issue the results in writing to the Contractor upon completion of the performance review.

Remedial Actions. Perform Remedial Actions by October 15th of the same year as the review. If the Department determines that immediate repairs are necessary, due to a potential hazard to the traveling public, the Department will notify the Contractor and establish a date that all repairs are to be finished.

Provide construction traffic control when performing any work required or allowed by this specification in accordance with current Department policy and the Ohio Manual of Uniform Traffic Control Devices. Obtain Department approval for the time the work will be performed.

Provide approved materials, equipment, and labor to perform Remedial Actions at no additional cost to the Department. Prior to performing a Remedial Action, submit a Remedial Action plan to the DCE for approval. State in the plan when and how the Remedial Action will be performed; what material will be used; and how traffic will be controlled. Warrant Remedial Action work for the remainder of the warranty period.

Use only microsurfacing for permanent repair and resurfacing areas. Perform temporary repairs using material approved by the DCE. Replace temporary repairs with a permanent repair as soon as weather permits.

Replace pavement markings or raised pavement markers (RPM) removed, obliterated, or damaged while performing a Remedial Action with equivalent approved pavement markings or RPM products at no cost to the Department.

The Contractor is not responsible for pavement damage beyond the Contractor's control (i.e., car fire, oil spill, structural issues etc.).

TABLE 421.14-1

Defect Type	Threshold Level [6] (allowable distress levels)
Non-uniform texture [1]	300 square feet (28 m^2)
Surface Loss [2]	20 square feet (1.8 m^2)
Raveling [3]	300 square feet (28 m^2)
Rutting [4] [5]	0.25 inch (6.5 mm) continuous in any Segment.
Notes:	
(1) Texture inconsistencies in either the transverse and or longitudinal direction.	
(2) Loss of surface by traffic wear, debonding, or delamination.	
(3) "Moderate" level raveling as defined in the Strategic Highway Research Program (SHRP) "Distress Identification Manual for the Long-Term Pavement Performance Project" (SHRP-P-338).	
(4) Measure the wheel path with a 4 foot (1.2 m) straight edge.	
(5) Only applies during the first 120 days of Warranty or after any Warranty work.	
(6) Based on 1000 foot (300 m) lane Segment. The beginning of a Segment is the beginning of any distress type.	

If any 1000 foot (300 meter) lane segment has repairs or defects greater than 5 percent of the area, resurface with a full lane width of microsurfacing meeting the requirements of this specification.

421.15 Method of Measurement. The Department will measure Microsurfacing, Surface Course and Microsurfacing, Leveling Course by the number of square yards (square meters), complete and accepted in place. The Department will base the width of the pavement course on the width shown on the plans, specified in this specification, or directed by the Engineer. The Department will measure the length along the centerline of each roadway or ramp.

The Department will measure the number of raised pavement markers removed.

The Department will measure Microsurfacing, Rut Fill Course by the number of tons (metric tons) of dry aggregate used, complete and accepted in place. The Department will base the weight of the dry aggregate used on the calibrated unit weight as reported from the aggregate delivery belt.

421.16 Basis of Payment. The cost of tack coat and Item 423 Crack Sealing is incidental to microsurfacing.

The Department will pay for removal of existing pavement markings according to 421.08 under Items 643, 644, 645, 646, 647, and 648 as specified. The Department will pay for removal of existing raised pavement markers according to Item 621 Raised Pavement Markers Removed.

The Department will pay for the construction of accepted test strips at the individual bid prices for the courses constructed.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
421	Square Yard (Square Meter)	Microsurfacing, Surface Course

421	Square Yard (Square Meter)	Microsurfacing, Surface Course (FR)
421	Square Yard (Square Meter)	Microsurfacing, Leveling Course
421	Ton (Metric Ton)	Microsurfacing, Rut Fill Course

ITEM 422 CHIP SEAL

422.01 Description. This work consists of preparing and applying a single or double chip seal. Warrant exposed chip seals for two years.

422.02 Materials. Use polymer emulsified binder conforming to 702.16 Type A.

Provide aggregate consisting of washed limestone or washed dolomite conforming to 703.05. Do not use an aggregate source designated with "SR" on the Aggregate Source Group list in accordance with 703.01.F. Additionally the following requirements apply:

Stockpile the material to be used for the chip seal at the aggregate source.

Obtain five (5) samples from the stockpile and perform gradation testing on each sample and determine the percent passing for each sieve size listed in Table 422.02-1

A. Calculate the total range for the No. 8 (2.36 mm) sieve for all five samples. The range will not exceed 6%.

B. Calculate the percent passing the No. 200 (75 µm) sieve for each sample. No single sample value will exceed 2.0 percent.

C. Calculate the average of each sieve for all five samples. Ensure the average value for each sieve is within the requirements of Table 422.02-1.

Submit a letter to the Engineer and District Testing containing the JMF gradations and the calculations to show the cover aggregate meets requirements.

If a staging location will be used for the chip seal aggregate first move the initially tested aggregates from the aggregate source stockpile to the staging location and construct a project-specific staging stockpile. Then obtain five (5) aggregate samples from the staging location stockpile and perform gradation testing on each sample to determine the percent passing for each sieve size listed in Table 422.02-1.

Evaluate the staging location aggregate samples the same as the aggregate source samples except allow an average for the No. 200 (75 µm) sieve not greater than 1.7 percent.

Submit the JMF gradations from the staged stockpile and the calculations to show the cover aggregate meets requirements in letter form to the Engineer and District Testing.

If the chip seal aggregates fail to meet requirements, either at the aggregate source or the staging location, re-wash and/or rework the aggregate materials and retest the new stockpiles.

TABLE 422.02-1

Sieve Size		Total Percent Passing	
		Type A	Type B
1/2 inch	(12.5 mm)	100	
3/8 inch	(9.5 mm)	85 to 100	100
No. 4	(4.75 mm)	5 to 25	85 to 100
No. 8	(2.36 mm)	0 to 10	5 to 30
No. 16	(1.18 mm)	0 to 5	0 to 10
No. 200	(75 µm)	0 to 1.5 [1]	0 to 1.5 [1]

[1] Washed gradation value

The District may obtain and test verification samples of the JMF aggregates at any time. If a single verification sample is either outside the values in Table 422.02-1 with the exception that the No. 200 (75 µm) value is not greater than 2.0 percent, the district will obtain five (5) samples and retest to determine if the aggregate JMF falls within the limits of Table 422.02-1. If the JMF verification test doesn't meet the source or staging location limits the stockpile is not acceptable.

422.03 Equipment. Provide equipment conforming to the requirements of this section. Obtain approval of equipment before starting the job.

Use equipment for binder distribution conforming to 407.03, except ensure that it has a computerized rate control that automatically adjusts the binder pump to the unit ground speed and has a gauge or meter in plain view for reading gallons (liters). Use appropriate spray nozzles for the material and rate specified. Adjust spray bar and nozzles to provide triple lap coverage.

Use Type II pneumatic tire rollers conforming to 449.02 with the exception of the requirements of Table 449.02-1 Roller Capacity. Use a minimum of 3 Type II pneumatic tire rollers capable of ballast loading. The roller weight must be between 6 to 8 Tons (5 to 7 metric tons) each to achieve a minimum contact pressure of 80 psi (550 kPa). Tires must be inflated to the proper pressure as specified by the roller manufacturer. Use self-propelled aggregate spreaders with a variable width aggregate hopper capable of placing from 8 to 16 feet (2.4 to 4.8 m) in any increment

and a computerized rate control that automatically adjusts the aggregate output to the unit ground speed. Equip spreaders with pneumatic tires, a screen to remove oversized material, revolving cylinders, and adjustments necessary to produce a uniform distribution of particles at the specified rate.

Furnish power sweepers, pickup sweepers, or rotary brooms as required for the initial surface preparation and for removing loose aggregate particles.

Furnish accurate thermometers for determining any of the applicable temperature requirements of this specification.

422.04 Weather Limitations. Place the chip seal when the pavement temperature is between 60 °F (16 °C) and 140 °F (60 °C). Do not schedule the performance of this work for the time period before May 1 or after September 15. Do not place chip seal if any of the following conditions exist:

A. The atmospheric temperature is below 70 °F (21 °C).

B. Impending weather conditions do not allow for proper curing.

C. If temperatures are forecasted below 50 °F (10 °C) within 24 hours from the time of work.

422.05 Test Strip. Construct a continuous 1000 foot (300 m) long by lane width test strip in the presence of the Engineer. Do not waive test strips regardless if the same materials have been used on another project.

Determine the initial binder application rates and aggregate application rates for the test strip to achieve 2/3 aggregate embedment.

For a single chip seal, Type A, an initial target rate of 0.37 ±0.03 gallon per square yard (1.68 L/m²) is recommended for the test strip. For a single chip seal, Type B, an initial target rate of 0.35 ±0.03 gallon per square yard (1.58 L/m²) is recommended for the test strip. For double chip seal, a target rate of 0.36 ±0.03 gallon per square yard (1.63 L/m²) for the first course and 0.33 ±0.05 gallon per square yard (1.49 L/m²) for the second course is recommended for the test strip. Notify the Engineer of the initial target rates.

Calibrate the aggregate spreader to ensure a uniform application rate in both the transverse and longitudinal directions. Verify the application rates with a one square yard (one square meter) piece of cardboard or other material to collect and weigh the aggregate. Adjust spreader rates to maintain application rate within 10% of the target rate. Do not over apply cover aggregate relying on vacuum and broom sweeping to pick up all excess. Amounts of loose aggregate that create a nuisance to the public will result in work stoppage. If work is stopped by the Engineer recalibrate the aggregate spreader determining a new application rate and apply cover aggregate at the new rate. Verify the aggregate gradation meets 422.10.C. during the test strip and provide the results to the Engineer.

The Engineer and Contractor will review the test strip the next workday for streaking, ridging, bleeding, aggregate loss or other problems. If the review shows the test strip meets the requirements of 422.11 and the application rate and quality control tests show all is in control compared to the JMF, then progress with the work. Should problems be noted, the Engineer may require another test strip.

JMF gradation targets may be adjusted once within the limits of Table 422.02-1 based on results of the approved test strip. Provide adjusted gradation targets to the Engineer and the DET prior to progressing with the work.

422.06 Surface Preparation. Clean the pavement according to 407.05. If necessary, clean areas of the pavement with a hand broom.

Remove all existing pavement markings so that less than 5% of the line remains visible. Repair damage to the pavement that results in the removal of more than 1/8 inch of pavement thickness. When a grinder drum is mounted to a skid steer loader, the drum must be able to accommodate a minimum of 150 teeth.

Remove the raised pavement markers according to 621.08.

Do not place material until the Engineer approves the existing surface.

422.07 Binder Application. Before applying binder, ensure that sufficient cover aggregate is available for immediate application. Apply the binder at the target rate(s) established from a successful test strip. Ensure distributor spray bar and nozzles are set to provide triple overlap coverage with no streak or drill patterns on the road surface.

Maintain the binder temperature from 150 to 185 °F (65 to 85 °C) during construction, including the start of each day. Reheat the binder at a rate of no more than 25 °F (14 °C) per hour, when the binder is allowed to cool below 150 °F (65 °C).

If the target application rates are not the optimum application rates to achieve proper stone embedment during the actual application, immediately notify the Engineer. Proper stone embedment is 2/3 of the stone chip height and can be checked by pulling out several chips by hand. Adjust and document the new application rate by stationing. Recheck stone embedment after adjustment and obtain the Engineer's approval of the new rate.

Do not allow the binder to streak on the road surface. If the Engineer determines that streaking is occurring, cease operations until the Engineer is satisfied that streaking has been eliminated.

At the beginning and at the end of a contract section, start and stop the application on a removable protective cover (paper, metal sheets, or other suitable material) sufficiently wide enough to allow full application on the surface being treated. Make transverse and longitudinal laps in such manner to ensure that the texture of the finished surface is uniform and continuous. To prevent lapping at transverse junctions, promptly shut off the binder spray at the end of the application. Before continuing the application, place a removable protective cover a sufficient distance back from the joint on the cover aggregate so the sprayers are operating at full force when the distributor has attained the predetermined speed upon reaching the uncovered surface. Upon completion, remove all removable protective covers.

422.08 Cover Aggregate Application. Verify the application rate with a one square yard (one square meter) piece of cardboard or other material to collect and weigh the aggregate before placing binder. Adjust if necessary and re-verify. Record final results and inform the Engineer. Immediately after applying the binder, apply

cover aggregate uniformly without ridges or laps at the specified rate adjusted as directed by the Engineer to produce a minimum of excess loose particles. Spread the material in such manner that the tires of the truck or aggregate spreader at no time contact the uncovered and newly applied binder. Before rolling, correct deficiencies in the application of cover aggregate in a manner satisfactory to the Engineer.

After rolling, protect the surface from traffic damage during the period required for the binder to cure sufficiently and prevent dislodging of the aggregate particles by normal traffic. During this period and as directed by the Engineer, correct deficiencies in cover aggregate by spreading additional aggregate or by light brooming.

Apply cover aggregate at a rate necessary to provide full coverage of the binder and to avoid tracking. Do not over apply cover aggregate relying on vacuum and broom sweeping to pick up all excess. Nuisance to the public amounts of aggregate will result in work stoppage. If work is stopped by the Engineer recalibrate the aggregate spreader determining a new application rate and apply cover aggregate at the new rate. If the target rate needs adjustment due to the gradation of the aggregate or due to existing surface conditions of the pavement, immediately notify the Engineer and document the new rate by stationing.

422.09 Construction Operation. Establish stations at 1000 foot (300 m) intervals on the entire project before placing materials. Clearly identify and maintain the stations until project completion.

Keep the binder distributor, aggregate spreader, and rollers as close to each other as possible. Do not allow the binder distributor to be more than 150 feet (45 m) ahead of the aggregate spreader.

Perform rolling immediately after placing the aggregate, but before the binder sets up. Do not leave aggregate unrolled for more than 5 minutes. Perform a minimum of two complete roller passes over the aggregate. A single complete pass is forward and backward over the same path. For each new pass, overlap the previous pass by about one-half the width of the roller. Use a minimum of three rollers, and roll in a longitudinal direction at a speed not greater than 5 miles per hour (8 km/h). Do not operate rollers at speeds that cause pick-up or dislodging of aggregate particles.

Within 4 hours of placement but after the binder sets, sweep the pavement as needed to remove all loose aggregate. Use pickup sweepers in curbed areas and where aggregate shoulders do not exist. Do not sweep loose aggregate onto lawns, curbed areas, or intersections.

If the pavement cannot be swept within the 4-hour period due to problems associated with the stone moisture, binder, breaking, humidity, or other unknown, the Engineer may suspend the operation until the problem is resolved or more suitable conditions are obtained to maintain the 4-hour time frame for sweeping. Extend sweeping 1 foot (0.3 m) beyond the edge of the chip seal to help prevent migration of loose aggregate back onto the pavement. Do not re-use aggregate from a chip seal that is swept from the pavement or that is already loose off the pavement edge.

Perform a final sweeping immediately before application of permanent pavement markings or a fog seal, if a fog seal is required. Use pickup sweepers in curbed areas and where aggregate shoulders do not exist. Do not sweep loose aggregate onto lawns, curbed areas, or intersections. The Contractor is responsible for claims of damage to vehicles prior to the final sweeping.

Wait at least 24 hours before placing the second course of a double chip seal. Ensure the first course of a double chip seal meets the gradation of Table 422.02-1 Type A and the second course meets the gradation of Table 422.02-1 Type B. Ensure that the first course meets requirements of this specification and is cured and capable of withstanding construction traffic without damage. If loose aggregate is evident, sweep the first course again just prior to placing the second course. Correct damage to the underlying chip seal before placing the second course.

Place the longitudinal construction joint on a lane line or as directed by the Engineer. For double chip seal, place the longitudinal construction joint for the first course 6 inches (150 mm) off the centerline and place the second course so the longitudinal joint is at the centerline.

Before opening to traffic, post the roadway with "Loose Gravel/Fresh Tar" signs and a "35 mph" speed plaque mounted below the sign. Ensure that signs conform to Item 614. Place these signs in the advance warning area and just beyond each intersecting road throughout the length of the activity area. Remove the signs as directed by the Engineer.

On two-lane roads or pavements where traffic is maintained on a chip seal constructed that workday, provide a traffic control pilot vehicle operated at no more than 25 miles per hour (40 km/h) in the immediate work area.

Protect all utility castings, monument boxes, and other similar items using tarpaper or other approved material. Remove protection before sweeping and opening to traffic.

422.10 Quality Control

A. General. Use the methods described in this section to measure compliance. If test results exceed any of the identified quality control tolerances, stop placement and immediately notify the Engineer and District Testing. Identify the cause of exceeding any of the identified quality control tolerances and document in detail the corrective action necessary to bring the deficiency into compliance. Obtain the Engineer's approval before resuming work. Upon resuming work, take another sample and immediately provide the test results to the Engineer. If the tolerances are exceeded, stop the work. Do not resume work until approved by the Engineer and District Testing. The Department can obtain samples of materials at any time. Aggregate samples can be taken from sources, on-hand stockpiles or the aggregate spreader box. Work can be stopped and materials can be rejected on the basis of poor Department test results. Any deficient materials found to be incorporated in the project will be evaluated per Supplement 1102.

B. Binder. Within one hour of start of production obtain and label a binder sample from the distributor truck and give the sample to the Engineer the same day. Provide and sample the binder in one quart plastic containers with plastic screw tops.

Label and retain one sample per each additional day for the Department. Take more samples when requested by the Engineer.

For the binder application rate, as determined by a yield check, do not exceed a tolerance of ±0.02 gallon per square yard (0.09 L/m²) from the established application rate.

C. Coarse Aggregate. At a minimum test one sample taken from the aggregate spreader box or project-specific stockpile at production start and sample and test one sample from the aggregate spreader box or project-specific stockpile randomly during the day. Provide the Engineer with a split sample that is a minimum of 22lbs (10,000g) from each day's random sample for verification testing. An aggregate spreader box sample may be taken by laying a piece of suitable material under the spreader as it moves forward. Include additional testing when directed to sample and test by the Engineer. Sample and test aggregate according to AASHTO R 90, AASHTO R 76, and Supplement 1004 (AASHTO T 11 where required). Use washed gradations for determining the percent passing the No. 200 (75 µm) sieve. Submit daily test results to the Engineer prior to beginning the next day's production. The Contractor may use additional tests. These may include dry gradations for control purposes but acceptance of on-hand aggregate will be based on washed gradations only. Reject and do not use aggregate creating dusting nuisance to the public on the project.

Reject truckloads of aggregate if water is seen coming from the truck bed.

Reject aggregate that does not meet the following requirements:

No. 4 (4.75 mm) sieve from JMF	±5.0%
No. 8 (2.36 mm) sieve from JMF	±3.0%
No. 200 (75 µm) sieve from JMF	±1.0%, 2.05% upper limit
Aggregate moisture content (by dry weight)	4.0% max. for aggregates with an Absorption > 2.0%, 3.0% max. for aggregates with an Absorption ≤ 2.0%

D. Documentation. Provide the Engineer a daily report with the following:

1. Project number, county, route.
2. Date, air temperature, pavement temperature, and humidity.
3. Binder temperature.
4. Beginning and ending stations.
5. Target binder and aggregate application rates.
6. Yield checks on binder (three per day, minimum).
7. Yield checks on aggregate (three per day, minimum).
8. Gradation, moisture content, and station (One sample from spreader box at production start, one random sample during the day and any other samples when directed by the Engineer).

9. Length, width, and total area.

10. Condition of "Loose Stone" signs with "35 mph" speed plaques.

11. Contractor representative's signature.

Provide a bill of lading for binder and aggregate when requested or at project completion.

422.11 Acceptance. Inspect the chip seal daily for deficiencies resulting from poor workmanship, flushing, tracking from equipment, surface patterns, loss of stone, and sweeping. Inspect workmanship for untreated areas, minimum overlap on longitudinal joints, and minimum overlap on construction joints.

Verify the following for daily acceptance:

A. Finished surface has no more than four tears or untreated areas greater than 1 inch (25 mm) wide and 4 inches (100 mm) long in any 120 square yard (100 m^2) area.

B. Joints appear neat and uniform without buildup, uncovered areas, or unsightly appearance.

C. Longitudinal joints have less than a 2 inch (50 mm) overlap on the adjacent passes.

D. Transverse joints have no more than 1/4-inch (6 mm) difference in elevation across the joint as measured with a 6 foot (2 m) straightedge.

E. Chip seal edge is neat and uniform along the roadway lane, shoulder, and curb lines.

F. Chip seal edge has no more than 2 inch (50 mm) variance in any 100 feet (30 m), along the roadway edge or shoulder.

G. Typical stone chip embedment is 2/3 of typical stone chip height.

For project acceptance, the Contractor and Engineer will review the completed work 25 to 35 days after placement. The finished work must meet the following requirements:

Defect [1]	**Severity**
Surface patterns	Alternate lean and heavy lines (Ridges or streaking over the surface)
Bleeding/flushing	Distinctive appearance (Excess binder on surface)
Loss of cover aggregate	Patches or lines of aggregate lost from surface
[1] No more than 20% of any 120 square yard (100 m^2) area can contain any defect. The measurement of the 120 square yard (100 m^2) area begins at the start of the defect.	

Perform all corrective work to the satisfaction the Engineer.

422.12 Performance Review. Perform remedial actions for any defect exceeding the threshold levels in Table 422.12-1 for a period of two years from the date of substantial work complete as documented on the Department's Form C-85.

Contact the Department to schedule a final performance review at least 60 days prior to the end performance review period. The Department will review the pavement before the end of the two year performance review period to determine if remedial action is required. The Department will issue the results in writing to the Contractor upon completion of the performance review.

Remedial Actions. Perform Remedial Actions between May 1 and September 1. If the Department determines that immediate repairs are necessary, due to a potential hazard to the traveling public, the Department will notify the Contractor and establish a date that all repairs are to be finished.

Provide construction traffic control when performing any work required or allowed by this specification during the warranty period in accordance with current Department policy and the Ohio Manual of Uniform Traffic Control Devices. The Department will approve when the work is performed.

Provide approved materials, equipment, and labor to perform Remedial Actions at no additional cost to the Department. Prior to performing a Remedial Action, submit a Remedial Action plan to the DCA for approval. State in the plan when and how the Remedial Action will be performed; what material will be used; and how traffic will be controlled. Warrant Remedial Action work for the remainder of the warranty period.

Replace pavement markings or raised pavement markers (RPM) removed, obliterated, or damaged while performing a Remedial Action with pavement markings or RPMs equal approved products at no cost to the Department.

The Contractor is not responsible for pavement damage beyond the Contractor's control (i.e., car fire, oil spill, structural issues, etc.).

TABLE 422.12-1

Each segment will be 300 ft (91 m) in length and the width of the lane. The beginning point of a 300 ft (91 m) segment starts at the beginning of any individual defect type. For loss of aggregate, the beginning point of a 300 ft (91 m) lane segment will exclude locations where vehicles turn from or onto other state highways.		
Defect	**Severity**	**Threshold Levels**
Surface Patterns	**Severe** - light and heavy lines over the pavement surface	40% of segment length affected, continuous or localized
Bleeding/ Flushing	**Moderate** - excess binder on surface (loss of stone/tire contact) not subject to wearing off quickly	5% of segment length affected continuously or total of 20% localized problems
Loss of Aggregate	**Moderate**- patches of aggregate loss	10% of segment length affected continuously or total of 20% localized problems

422.13 Method of Measurement. The Department will measure Single Chip Seal or Double Chip Seal by the number of square yards (square meters) of

aggregate, and the gallons (liters) of polymer emulsified binder, completed and accepted in place. The Department will determine the width by measuring the actual width of the chip seal. The Department will determine the length along the centerline of each roadway or ramp. The Department will determine the gallons (liters) of polymer emulsified binder applied according to Item 109.

The Department will measure the number of raised pavement markers removed.

422.14 Basis of Payment. The Department will not pay for materials, equipment, or labor to make corrections.

The Department will pay for removal of existing pavement markings according to Items 643, 644, 645, 646, 647, and 648 as specified.

The Department will pay for removal of existing raised pavement markers according to Item 621 Raised Pavement Markers Removed.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
422	Square Yard (Square Meter)	Aggregate, Single Chip Seal, Type __
422	Gallons (Liters)	Emulsion, Single Chip Seal, Type ___
422	Square Yard (Square Meter)	Aggregate, Double Chip Seal, Type ___
422	Gallons (Liters)	Emulsion, Double Chip Seal, Type ___

ITEM 423 CRACK SEALING, HOT APPLIED

423.01 Description. This work consists of preparing and sealing pavement cracks with a hot applied crack sealant.

423.02 Materials. Furnish hot applied crack sealant, of the type specified, conforming to:

Type I..... 705.04
Type II 702.17.B
Type IV 702.17.D

Furnish Type I crack sealant material according to the Department's TE-24 system before shipping to the project. Obtain approval of other crack sealants according to 702.17.

423.03 Equipment. Equipment used in the performance of this work is subject to the Engineer's approval and to the requirements of 108.05.

For Type I crack sealant, heat the sealant in a kettle or melter constructed as a double boiler, with the space between the inner and outer shells filled with oil or other heat-transfer fluid. Use a kettle or melter with positive temperature control of the oil bath, and provide a mixing vat, mechanical agitation, and recirculating pumps. Do not apply direct heat to the sealant.

For Types II and IV crack sealants, heat the sealant in a kettle or melter constructed as a double boiler, with the space between the inner and outer shells filled with oil or other heat-transfer fluid. Use a kettle or melter with separate thermometers for the oil bath and mixing vat. Equip the kettle with a full sweep type agitator. Also, equip the kettle with a 2-inch (50 mm) minimum recirculating pump to provide circulation of the materials when not applying the crack sealant. Do not apply direct heat to the sealant.

For Types I and IV crack sealants, use a mechanical applicator wand capable of continuously feeding the sealant through nozzles shaped to penetrate the cracks. A positive sealant flow shutoff mechanism is required. Ensure that the wand produces a band according to the tolerances of 423.07.

For Type II crack sealants, use a mechanical applicator wand head capable of placing the crack sealant according to the tolerances of 423.07 while filling the cracks. A positive sealant flow shutoff mechanism is required.

Use portable air compressors capable of furnishing at least 100 pounds per square inch (690 kPa) of air pressure at the nozzle. Use compressors equipped with traps that maintain the compressed air free of oil and water.

Use water cleaning equipment capable of delivering water at 2000 pounds per square inch (14 MPa) of pressure from a nozzle to the crack being cleaned.

Use a propane lance unit capable of producing a blast of hot air that operates at 1000 °F (538 °C) and a gas velocity of 2000 feet per second (600 m/s).

Use mechanical and power driven routing and sawing equipment capable of following close to the path of cracks and of widening the cracks to the required dimension without causing excessive spalling or damage to the adjacent pavement. For sawing equipment, use diamond saw blades with a diameter of 8 inches (200 mm) or less.

423.04 Weather Limitations. Do not seal cracks if the surface is visibly damp or the temperature is below 45 °F (7 °C).

423.05 Preparation. Fill all visible cracks according to 423.07 or as directed by the Engineer.

If routing is specified, rout cracks with an opening less than 3/4 inch (19 mm) to provide a sealant reservoir with a nominal size of 3/4 inch (19 mm) wide by 1 inch (25 mm) deep.

If sawing is specified, saw all cracks to 3/4 to 7/8 inch (19 to 22 mm) wide and 7/8 to 1 inch (22 to 25 mm) deep. Use hand tools or a lightweight chipping hammer to remove all slivers of asphalt concrete less than 1 inch (25 mm) wide remaining along the crack after sawing. Immediately before sealing, sandblast both faces of the sawed crack to remove all contamination and to texture the faces. If the crack below the sealant reservoir is greater than 3/8 inch (10 mm) wide, insert a backer rod into the crack to form the bottom of the reservoir at the proper depth.

Before applying the hot sealant, clean cracks by an approved method or methods to remove dust, dirt, moisture, vegetation, and other foreign material. Keep the cracks clean and dry until all sealing operations are completed.

423.06 Mixing Type II. Use weigh tickets in determining the specified proportion of fiber to blend into the binder. Add fibers to the binder, and mix thoroughly in the kettle. Type II crack sealant may also be prepackaged per 702.17.B. Do not allow the temperature of the sealant in the field application to exceed the safe heating temperature recommended by the manufacturer.

423.07 Application of Sealant. Perform the crack sealing operation within 250 feet (76 m) of the cleaning operation.

Seal only cracks that are wide enough to permit entry of sealant. Seal tightly closed cracks (less than 1/4-inch (6 mm) wide) only if they show signs of raveling or spalling. Do not seal cracks greater than 1-inch (25 mm) wide, and do not seal spalls or cavities greater than 4 inches (100 mm) wide, unless otherwise directed.

For Types I and IV crack sealants, fill the entire crack reservoir with the sealant from the bottom up to approximately 1/16 inch (2 mm) above the pavement surface. Immediately scrape the filled cracks with a V-shaped or U-shaped squeegee, or similar hand tool, to smooth the overfill. This may require more than one application of sealant. The Engineer will not accept the work if the band of sealant on the pavement surface is greater than 2 inches (50 mm) wide.

For Type II crack sealants, place the sealant such that it fills the cracks with a band of sealant within 2 to 4 inches (50 to 100 mm) wide. The Engineer will not accept the work if the thickness on the pavement is greater than 3/16 inches (5 mm).

423.08 Opening to Traffic. Do not allow traffic on the sealant until it has cured and the possibility of tracking no longer exists. However, if the Engineer determines it is necessary to allow traffic to pass over the sealant before adequate curing, dust Portland cement or other approved material over sealed cracks to eliminate pickup or tracking.

423.09 Method of Measurement. The Department will measure Crack Sealing, of the type specified, by the number of pounds (kilograms) of hot applied sealant in place, completed, and accepted.

The Department will measure Crack Sealing, of the type specified, by the square yards of sealing completed and accepted.

423.10 Basis of Payment. The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
423	Pound (Kilogram) or Square Yard (Square Meter)	Crack Sealing, Type I
423	Pound (Kilogram) or Square Yard (Square Meter)	Crack Sealing with Routing, Type I
423	Pound (Kilogram) or Square Yard (Square Meter)	Crack Sealing with Sawing, Type I
423	Pound (Kilogram) or Square Yard (Square Meter)	Crack Sealing, Type II
423	Pound (Kilogram) or Square Yard (Square Meter)	Crack Sealing, Type IV

ITEM 424 FINE GRADED POLYMER ASPHALT CONCRETE

424.01 Description. This work consists of constructing a surface course of aggregate and polymer modified asphalt binder mixed in a central plant and spread and compacted on a prepared surface. The requirements of Items 401, 402, 403, and 440 apply with the additional requirements of this specification.

424.02 Composition.

A. Type A. Use 8.5 percent modified asphalt binder by total mix weight. The requirements of 440.04 and 440.06 do not apply for Type A mix designs

B. Type B. Submit a proposed JMF according to Item 440 to the Laboratory that meets the requirements of a Type 1 surface course, except as follows:

1. Minimum VMA, 15.0 percent
2. Minimum total binder content, 6.7 percent
3. Design air voids, 4.0 percent
4. For projects with less than 1500 trucks use 50 blows, for projects with greater than or equal to 1500 trucks use 75 blows. If multiple sections with differing traffic counts occur on a project use 75 blows for the project.

Trucks = Current ADT × T24

Where:

Current ADT = current average daily traffic count from the plans

T24 = percent trucks per day from the plans

C. Asphalt Binder. Use a PG 76-22M asphalt binder; or a PG 64-22 asphalt binder modified by adding 5.0 ±0.3 percent by weight Styrene Butadiene Rubber (SBR) solids and meeting the requirements of PG 76-22. Provide SBR conforming to 702.14. Provide mineral filler conforming to 703.07.

D. RAP and RAS. Do not use RAS. Ten percent RAP may be used in a Type B mix if all requirements of footnote [3] in Table 424.02-1 are met by the RAP. Do not use RAP in a Type A mix.

E. Aggregate. Furnish clean, uncoated aggregate conforming to the applicable requirements of Table 424.02-1 and quality requirements of 703.05.

TABLE 424.02-1 - MIX GRADATION

Sieve Size		Total Percent Passing	
		Type A [1][2]	Type B [1][3][4]
1/2 inch	(12.5 mm)		100
3/8 inch	(9.5 mm)	100	95 to 100
No. 4	(4.75 mm)	95 to 100	85 to 95
No. 8	(2.36 mm)	90 to 100	53 to 63
No. 16	(1.18 mm)	80 to 100	37 to 47
No. 30	(600 µm)	60 to 90	25 to 35
No. 50	(300 µm)	30 to 65	9 to 19
No. 100	(150 µm)	10 to 30	--
No. 200	(75 µm)	3 to 10	3 to 8

[1] Gradation includes any mineral filler and is specified in percent passing.

[2] Use natural sand with at least 50 percent silicon dioxide by weight according to 703.05D.

[3] Fine Aggregate - Use natural sand with at least 50 percent silicon dioxide by weight according to 703.05D. For 50 blow mixes, use no more than 20 percent limestone sand, No. 10 limestone, or combination of both by weight of total aggregate. For 75 blow mixes, use 20 percent limestone sand, No. 10 limestone, air cooled slag sand or combination thereof by weight of total aggregate. If 10 percent RAP is used the silicon dioxide content of the total natural sand blend must be at least 50 percent. Contact OMM for guidance on submitting RAP aggregate silicon dioxide data.

[4] Coarse Aggregate - For 50 blow mixes, for the final blend of all coarse aggregate use a minimum 10 percent two or more fractured faces aggregate. For 75 blow mixes, use 100 percent two or more fractured faces aggregate. Meet the two or more fractured faces aggregate criteria of ASTM D5821-13.

424.03 Mixing. Discharge the mix from the plant at temperatures from 335 °F to 370 °F (168 °C to 188 °C) for hot mix asphalt or 300 °F to 340 °F (149 °C to 171 °C) for warm mix asphalt

424.04 Acceptance. The Department will base acceptance of the asphalt concrete mix on the item specified in the Contract item description. (i.e., 448, 449). For Type A mixes comply with acceptance requirements of 449.

424.05 Method of Measurement. For Type A mixes use a unit weight conversion of 1.75 tons/cubic yard (2.08 metric tons/cubic meter).

424.06 Basis of Payment. Include the cost of asphalt material to coat vertical faces and seal joints and gutters in the contract unit price for Item 424.The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
424	Cubic Yard (Cubic Meter)	Fine Graded Polymer Asphalt Concrete, Type A, (449)
424	Cubic Yard (Cubic Meter)	Fine Graded Polymer Asphalt Concrete, Type B, (___)

ITEM 440 ASPHALT CONCRETE MIX DESIGN — GENERAL

440.01 Description. This specification describes the general requirements for asphalt concrete pavement mix design for base, intermediate, and surface courses. Provide laboratory and personnel meeting the requirements of Supplement 1041 to perform mix designs.

Do not start mix production without a preliminary JMF approval and 48 hour notification of District Testing. Final approval of a JMF will be based on field verification. Obtain a new JMF for any desired change to an existing JMF in excess of those allowed in 403.07.

440.02 Materials. Furnish materials conforming to:

Asphalt binder 702.01
Aggregates (base courses) 703.04
Aggregates (intermediate and surface courses) .....
..... 703.01 and 703.05
Mineral filler 703.07

If 100 percent of coarse aggregate in an asphalt mix design is steel slag (703.01.E), the Contractor may include steel slag as a maximum of up to 50 percent of fine aggregate. If a steel slag source causes bulking (expansion resulting in flushing or material loss) in asphalt concrete courses, OMM will place limits on the amount of steel slag allowed in a mix design. Bulking may be shown through testing, such as ASTM D 4792, or through field failure such as, but not limited to, flushing on newer pavement or apparent over-asphalting in production. The Department may require the steel slag processor at any time to perform additional testing to verify steel slag properties. Potential mix problems due to poor control of steel slag aggregate include bulking, poor gradation and specific gravity control resulting in highly variable void properties, excess soft pieces resulting in pock marks, flushing, etc.

440.03 JMF Submittal. Submit no more than two JMFs for each asphalt concrete pay item per project. Additional submittals are at the discretion of OMM. Develop a JMF to comply with the mix design criteria and submit it to OMM on approved forms at least two weeks prior to the start of production for preliminary approval. OMM may require additional time prior to preliminary approval to perform tests on lab or plant produced mixtures to ensure adequate mix performance. OMM will notify the Contractor if additional time for testing is required. Based on the results of this testing, OMM may require the Contractor to design a new JMF.

Identify the PG Binder supplier, as well as the polymer type if applicable, on the JMF submittal. A change in polymer asphalt binder or polymer source will require a redesign. Provide on one page neatly summarized, dated test results for the requirements of Table 702.01-1. Ensure data is no more than two months old. If SBR polymer is added at the asphalt concrete mixing plant, provide in the JMF data from the SBR polymer supplier for total solids (percent) and ash (percent) according to the 702.14. As well, provide the target amount of SBR polymer greater than or equal to 3.5 percent to achieve the properties specified. Include a letter of certification from the polymer supplier verifying percent butadiene in the SBS or SBR polymer. Report in the JMF submittal results of temperature-viscosity testing for mixing and compaction temperatures. For polymer asphalt binders, supplier recommended temperatures may be used in lieu of the temperature-viscosity results, but the temperature-viscosity results must still be reported.

For Superpave mixes, include the standard Department cover and summary page, all printouts from the gyratory compactor (all gyratory points not necessary), and analysis covering the required mix properties in the JMF submittal.

Ensure the JMF submittal includes the percentages of RAP, RAS, virgin aggregates, and virgin asphalt binder required for the mix item. Report all RAP and RAS test results, including binder blend analysis, in the JMF submittal. Identify the RAP in the JMF submittal as to project origin and mix type(s). Identify the approved manufactured shingle waste manufacturer source or the approved tear-off RAS processor in the JMF submittal.

Provide the required certification forms in the JMF submittal documenting that the RAS meets AASHTO MP 23-15 (2020), Section 4 and that RAS from roofing tear-offs conforms to the EPA's NESHAP, 40 CFR 61 Subpart M, and other applicable agency requirements for asbestos.

Note on the JMF submittal RAP page which of Method 1 or Method 2 methods described below apply to the RAP.

For mixes using Method 1 that will contain up to 10 percent RAP and no RAS, the JMF submittal is not required to include the RAP except when a virgin polymer asphalt binder is used in a surface course. In addition, for surface course JMF submittals having polymer asphalt binder and RAP, including 424 mixes, do not submit any blends having 1 through 9 percent RAP.

For mixes using Method 2 that will contain up to 15 percent RAP and no RAS, the JMF submittal is not required to include the RAP unless a virgin polymer asphalt binder is used in a surface course. In addition, for surface course JMF submittals

having polymer asphalt binder and RAP do not submit any blends having 1 through 9 percent RAP.

Include RAS in a JMF submittal according to the Standard RAP/RAS Limits Table 440.05-1 or Extended RAP/RAS Limits Table 440.05-2 unless specified differently in the applicable mix specification.

Include any required antistrip additive in the mix design. Submit the following to OMM with the proposed JMF:

A. All TSR data (before and after the addition of the antistrip additive).

B. Rate of addition of the liquid antistrip material, if used.

C. If using liquid antistrip material submit product information, information on use by other State DOTs using the liquid antistrip material, and a letter of certification. If using hydrated lime submit certified test data showing the hydrated lime conforms to AASHTO M 303, Type 1.

D. Results of the washed gradation test of the individual components of the mix used in determining the combined gradation.

E. Results of the adherent fines testing for each component.

OMM may perform additional tests on lab or plant produced mix according to Supplements 1004, 1051, and 1052. If a change in the aggregate production is suspected, the Laboratory may require the Contractor to perform washed gradations on components and calculate adherent fines to determine the need for additional TSR review.

440.04 Composition. Perform the mix design and supply all required data in a manner taught in Level 2 Asphalt Technician School, Level 3 Asphalt Mix Design School and in the most recent Asphalt Institute Manual Series No. 2 (MS-2). OMM may visit the Level 3 mix design lab for review. Provide a mix design with at least four asphalt binder content points, including a minimum of two points above and two points below the JMF asphalt binder content. Design using HMA temperatures and do not use WMA additives during design. Use a 2 hour cure for volumetric mix samples and ensure the cure temperature and specimen compaction temperature are the same. Select the JMF asphalt binder content using the design air voids of the mix type and ensure the JMF meets the other requirements of the specified mix. Determine air voids from specimens prepared and tested according to Supplement 1036. Unless otherwise directed, submit an uncompacted sample for MSG representing the JMF meeting the minimum sample size in Supplement 1036 and three Marshall or two gyratory compacted specimens at design air voids. Submit additional samples as requested by OMM.

Do not apply the gradation requirements of 703.05 for fine aggregate.

If the F/A ratio using total asphalt binder content is greater than 1.0 recalculate it using the effective asphalt binder content. Calculate the effective asphalt binder content according to the MS-2. The value (calculated to the nearest percentage point) of the Fifty to Thirty (F-T) value, is the percent of total aggregate retained between the No. 50 (300 µm) and No. 30 (600 µm) sieves, minus the percent of total aggregate retained between the No. 30 (600 µm) and No. 16 (1.18 mm) sieves.

The Contractor may use the Marshall flow test in Superpave design as an indicator of potential for excess tenderness.

440.05 Reclaimed Asphalt Concrete Pavement and Reclaimed Asphalt Shingles. Provide reclaimed asphalt concrete pavement (RAP) and reclaimed asphalt shingles (RAS) according to the following requirements when choosing to use one or both in a mix. Failure to follow these requirements will result in a rejection of the Contractor QCP (403.03); restriction of the use of any RAP, RAS, or both at the facility; a change to Restricted Acceptance at the facility; or any combination thereof.

Provide RAP obtained from verifiable Department or Ohio Turnpike Commission projects and RAS obtained from un-used manufactured shingle waste or used roofing tear-off shingles as listed in Tables 440.05-1 and 440.05-2 and as follows. If the RAP is not from the above sources or the source is unknown, process and blend the RAP into a single uniform stockpile, test according to Level 3 Asphalt Mix Design requirements and obtain OMM approval for use. Obtain written approval from OMM for use of unusually large, old RAP stockpiles of unknown content, age, or both. Include approved methods in the QCP for ongoing processing and testing of these piles. Ensure no foreign or deleterious material is present in RAP. Use approved RAS suppliers meeting the requirements of Supplement 1116.

Ensure that the percentages of RAP and RAS fall within the specified limits of the required mix item.

Determine the final RAP gradation and asphalt binder content on a minimum of four separate stockpile (or roadway for concurrent grinding) samples. A RAP pile will be considered established if all samples agree within a range of 0.4 percent for asphalt binder content and 5 percent passing the No. 4 (4.75 mm) sieve. If fractionated RAP is used, use a suitable sieve for determining gradation uniformity. Determine RAP binder content from a centrifuge extraction test. Do not use reflux extraction or oven burnoff. Do not add RAP or other materials to established RAP piles. Once an established RAP pile is added to or used up, the RAP pile is no longer established and all JMF's associated with the pile are no longer approved. Notify OMM of JMF's impacted and JMF approval will be withdrawn. Use no more than 3.0 percent RAS by dry weight of mix. For design assume 12.0 percent available RAS binder. Determine gradation and specific gravity according to AASHTO PP 78-17 (2020), Section 5 or subsequent AASHTO applicable standard.

If the uniform stockpile will be processed into the asphalt plant using plant cold feed in line processing determine the processed RAP properties for use in the mix design. Record in the JMF submittal both the uniform stockpile and in line processed RAP properties.

Submit a new JMF for each existing mix type on the project (or each milling pass of two types) desired for use as concurrent project RAP.

A. RAP and RAS Usage Limits and Requirements. Follow Method 1 or Method 2 when using RAP, RAS , or both. When using RAS without RAP apply the virgin binder requirements of Table 440.05-2 Method 2. Use PG 64-28 virgin binder in all 442 intermediate courses regardless of the percentage of RAP used. If greater than 25 percent RAP is used in a JMF submittal use PG 58-28 or PG 64-28

virgin binder. If 26-30 percent RAP is used in the JMF submittal, the Contractor may submit a 3000 gram RAP sample along with a blend chart, according to Level 3 Mix Design procedures, to determine the grade of virgin asphalt binder to use. When using both 15 percent or greater RAP and 3 percent RAS in in the JMF submittal for intermediate and base courses, use PG 58-28 or PG 64-28. ODOT may request RAP samples, RAS samples, binder properties, or any combination at any time.

B. Method 1 Standard RAP. Limit RAP and RAS according to the Standard RAP/RAS Limits Table 440.05-1 unless specified differently in the applicable mix specification.

TABLE 440.05-1 METHOD 1 – STANDARD RAP/RAS LIMITS

Asphalt Mix Application	Percent RAP by Dry Weight of Mix, Max.[1]	RAS Usage [2]	Total Virgin Asphalt Binder Content, Min.	Comments
442 Polymer Surface Course	10%[3]	None	5.2	Polymerized binder is virgin. (For non-polymer virgin binder allow 20% max RAP)
424 Fine Graded Polymer	10% [3][4]	None	[5]	
441 Surface Course	20%	None	5.0	Polymer or non-polymer virgin.
441, 442 Intermediate Course	35%	Manufacturing waste and tear-offs	3.0	Any mix type used as an intermediate course.
301 Base Course	50%	Manufacturing waste and tear-offs	2.7	OMM will establish the asphalt binder content.
302 Base Course	40% (30%)	Manufacturing waste and tear-offs	2.0	OMM may limit RAP to 30 percent, eliminate RAS, or both if poor production mixing or coating is evident.[6]

[1] When using RAP and RAS in combination, use no more than 25 percent RAP.
[2] No more than 3.0 percent RAS by dry weight of mix.
[3] Use zero or 10 percent. Do not submit blends with 1 to 9 percent RAP.
[4] Type B mixes only. Do not use RAP in Type A mixes.
[5] The requirements of 424 apply.
[6] OMM will adjust the virgin binder content if the lower limits apply.

C. Method 2 Extended RAP. Limit RAP and RAS according to the Extended RAP/RAS Limits Table 440.05-2 unless specified differently in the applicable mix specification. Use Method 2 only with counter flow drum plants or mini-drum batch plant configurations meeting 402.

TABLE 440.05-2 METHOD 2-EXTENDED RAP/RAS LIMITS

Asphalt Mix Application	Percent RAP by Dry Weight of Mix, Max.[1]	RAS Usage[2]	Total Virgin Asphalt Binder Content, Min.	Comments
442 Polymer Surface Course	15%[3]	None	5.0	Polymerized binder is virgin. (For non-polymer virgin binder allow 25% max RAP)
424 Fine Graded Polymer	10% [3][4]	None	[5]	
441 Surface Course	25%	None	5.0	Polymer or non-polymer virgin.
441, 442 Intermediate Course	40%	Manufacturing waste and tear-offs	3.0	Any mix type used as an intermediate course.
301 Base Course	55%	Manufacturing waste and tear-offs	2.5	OMM will establish the asphalt binder content.
302 Base Course	45% (35%)	Manufacturing waste and tear-offs	1.8	OMM may limit RAP to 35 percent, eliminate RAS, or both if poor coating is evident.[6]

[1] When using RAP and RAS in combination, use no more than 25 percent RAP.
[2] No more than 3.0 percent RAS by dry weight of mix.
[3] Use zero or 10 percent. Do not submit blends with 1 to 9 percent RAP.
[4] Type B mixes only. Do not use RAP in Type A mixes.
[5] The requirements of 424 apply.
[6] OMM will adjust the virgin binder content if the lower limits apply.

440.06 Antistrip Additive. If the proposed JMF contains any gravel coarse aggregate, or contains more than 25 percent natural sand, or contains more than 20 percent RAP containing gravel coarse aggregate, or is designed according to Item 442 conduct the following tests:

TABLE 440.06-1 ANTISTRIP TESTS

Test Description	Specification
Moisture damage potential test	Supplement 1051
Washed gradation	AASHTO T 11 as modified by Supplement 1004
Adherent fines test for each component	ASTM D 5711

Modify the mix with liquid antistrip material or hydrated lime if the results of the moisture damage potential test show the Tensile Strength Ratio (TSR) of the asphalt concrete mix to be less than 0.80 for 442 mixes or 0.70 for all other mix types.

A. Liquid Antistrip Material. Include liquid antistrip material at a rate of 0.5 to 1.0 percent by weight of the asphalt binder. However, if 442 is specified, include

liquid antistrip material at a rate of 0.50 to 1.25 percent by weight of the asphalt binder. Ensure the TSR of the asphalt concrete mix is greater than or equal to 0.80 after the addition of the liquid antistrip material.

B. Hydrated Lime. Include hydrated lime in the dry form at a rate of 1.0 percent by the dry weight of aggregate for asphalt concrete except use 0.75 percent for 302 mixes. Conform to AASHTO M 303, Type 1 for hydrated lime. Ensure the TSR of the asphalt concrete mix is greater than or equal to 0.80 after the addition of the hydrated lime.

440.07 Tonnage Conversion. If an OMM established mix design conversion factor from the approved JMF is not available, OMM will use the factors in Table 440.07-1.

TABLE 440.07-1 CONVERSION FACTORS

Aggregate	lb/yd³	(kg/m³)
Gravel and stone	4000	(2370)
Slag less than 90 lb/yd³ (less than 1450 kg/m³) [1]	3600	(2135)
Slag 90 to 100 lb/yd³ (1450 to 1600 kg/m³) [1]	4000	(2370)
Slag more than 100 lb/yd³ (more than 1600 kg/m³) [1]	4300	(2550)

[1] Based on average dry rodded weight at the Laboratory.

ITEM 441 MARSHALL ASPHALT CONCRETE

441.01 Description
441.02 Composition
441.03 Acceptance
441.04 Basis of Payment

441.01 Description. This work consists of design, production, placement, compaction and testing of one or more courses of Marshall asphalt concrete, on a prepared foundation. The Marshall asphalt concrete consists of a mixture of graded aggregate and specified type and grade of asphalt binder that is designed using Marshall mix design procedures and a Marshall hammer. The aggregate and asphalt binder are mixed in a central plant then spread and compacted on the prepared surface. The requirements of Items 401, 402, 403, and 440 apply with the additional requirements of this specification.

441.02 Composition. Use a PG 64-22 asphalt binder for a Type 1 Intermediate course unless RAP, RAS, or both used according to 440.03 require a virgin binder grade change. Use a PG 64-22 asphalt binder for a Type 2 intermediate course unless RAP and/or RAS used according to 440.03 require a virgin binder grade change. Use a PG 64-22 asphalt binder and Type 1 surface gradation for asphalt concrete for driveways and under guardrails.

TABLE 441.02-1

Asphalt Mixture Composition			
Property	**Type 1 Surface**	**Type 1 Intermediate**	**Type 2 Intermediate**
1 1/2 inch (37.5 mm)[1]			100
1 inch (25.0 mm)[1]			95-100
3/4 inch (19.0 mm)[1]			85-100
1/2 inch (12.5 mm)[1]	100	100	65-85
3/8 inch (9.5 mm)[1]	90-100	90 to 100	
No. 4 (4.75 mm)[1]	45-57	50-72	35-60
No. 8 (2.36 mm)[1]	30-45	30 to 55	25-48
No. 16 (1.18 mm)[1]	17-35	17 to 40	16-36
No. 30 (600 μm)[1]	12-25	12 to 30	12-30
No. 50 (300 μm)[1]	5-18	5 to 20	5 to 18
No. 100 (150 μm)[1]	2-10	2 to 12	2 to 10
No. 200 (75 μm)[1]			
Asphalt Binder[2]	5.8-10.0	5.0 to 10.0	4.0 to 9.0
F/A Ratio, max.[3]	1.2	1.2	1.2
F-T Value[4]	+2	+2	
Blows[5]	50	50	50
Stability, min., pounds[5] (N)	1200 (5338)	1200 (5338)	1200 (5338)
Flow, 0.25 mm[5]	8 to 16	8 to 16	8 to 16
Design Air Voids[6]	3.5	3.5	4.0
VMA, min.[7]	16	16	13
CTIndex, min. [8]	Report	Report	Report

[1] Sieve, percent passing
[2] Percent of total mix
[3] Using effective asphalt binder content
[4] Percentage points maximum
[5] T 245
[6] Percent, Supplement 1036
[7] Percent, Supplement 1037
[8] Perform the IDEAL-CT and report results according to Supplement 1033

441.03 Acceptance. The Department will base acceptance of the asphalt concrete mix on the item specified in the Contract item description. (i.e., 446, 447, 448, 449).

441.04 Basis of Payment. Include the cost of asphalt material to coat vertical faces and seal joints and gutters in the contract unit price for Item 441. The Department will pay for accepted quantities at the contract prices as follows.

Item	**Unit**	**Description**
441	Cubic Yard (Cubic Meter)	Asphalt Concrete Surface Course, Type ___, (___), PG64-22
441	Cubic Yard	Asphalt Concrete Surface Course,

	(Cubic Meter)	Type ___, (___), PG70-22M
441	Cubic Yard (Cubic Meter)	Asphalt Concrete Intermediate Course, Type 1, (___)
441	Cubic Yard (Cubic Meter)	Asphalt Concrete Intermediate Course, Type 2, (___)
441	Cubic Yard (Cubic Meter)	Anti-Segregation Equipment

ITEM 442 SUPERPAVE ASPHALT CONCRETE

442.01 Description. This work consists of design, production, placement, compaction and testing of one or more courses of Superpave asphalt concrete, on a prepared foundation. The Superpave asphalt concrete consists of a mixture of graded aggregate and specified type and grade of asphalt binder that is designed using Superpave mix design procedures and a gyratory compactor. The aggregate and asphalt binder are mixed in a central plant then spread and compacted on the prepared surface. The requirements of Items 401, 402, 403, and 440 apply with the additional requirements of this specification.

442.02 Type A Mix Design.

Supply aggregate according to the lane current average daily truck traffic (Lane ADTT) as follows unless otherwise shown on the plans:

$$\text{Lane ADTT} = \text{Current ADT} \times T_{24} \times 0.45$$

Where:

Current ADT = current average daily traffic count from the plans

T_{24} = percent trucks per day from the plans

TABLE 442.02-1 GYRATION LEVEL AND MATERIAL REQUIREMENTS

Lane ADTT	Nini	Ndes	Nmax	Coarse Aggregate Angularity	Fine Aggregate Angularity	Flat and Elongated Particles	Sand Equivalent
<4000	7	65	105	95 [1] /90 [2]	44	10	45
≥4000	7	65	105	100 [1] /100 [2]	44	10	50

[1] Percent fractured (one or more faces) according to ASTM D5821
[2] Percent fractured (two or more faces) according to ASTM D5821

Submit aggregate to be used to OMM for approval a minimum of 3 weeks before submitting a JMF for approval.

If fine aggregate is from crushed carbonate stone or air-cooled blast furnace slag, the Department will not require the fine aggregate angularity (FAA) test. The Department will allow a blend of a material not meeting the FAA with a material

that meets the FAA, but calculate the FAA result based on the individual Department FAA results and actual blend percentages. Obtain OMM approval of any blends.

The restricted zone does not apply. Use control points according to MS-2, except as specified in Table 442.02-2.

TABLE 442.02-2 AGGREGATE GRADATION REQUIREMENTS

Sieve Size		9.5 mm mix	12.5 mm Surface Course Mix	12.5 mm Intermediate Course Mix	19 mm mix
		Total Percent Passing			
1 1/2 inch	(37.5 mm)	–	–	100	100
3/4 inch	(19 mm)	–	100	95 to 100	85 to 100
1/2 inch	(12.5 mm)	100	95 to 100	90 to 100	90 max
3/8 inch	(9.5 mm)	90 to 100	96 max	89 max	–
No. 4	(4.75 mm)	70 max	52 to 60[1]	60[1]	–
No. 8	(2.36 mm)	34 to 52	34 to 45	34 to 45	28 to 45
No. 200	(75 µm)	2 to 8	2 to 8	2 to 8	2 to 6
[1] For the No. 4 sieve do not exceed 63 in production.					

Ensure that the F/A ratio is a maximum of 1.2. Use a 2-hour cure for the mix design.

If more than 15 percent fine aggregate not meeting FAA is used, perform testing using the asphalt pavement analyzer (APA) according to Supplement 1057. To estimate an APA sample mix volume, use the bulk density from gyratory specimens at Ndes. Deformation less than 0.20 inch (5.0 mm) at 120 °F (49 °C) are considered passing for PG 58-28 and PG 64-22 mixes. Deformation less than 0.12 inch (3.0 mm) at 120 °F (49 °C) are considered passing for all other mixes.

Test design volumetric properties at Ndes. Test Nmax for the required criteria. Ensure that the VMA is not less than the minimum values of Table 442.02-3.

TABLE 442.02-3 VMA CRITERIA

Mix	VMA (percent minimum)
9.5 mm	15.0
12.5 mm Surface	14.0
12.5 mm Intermediate	14.0
19.0 mm	13.0

Perform the IDEAL-CT on all mixes and report results according to Supplement 1033.

442.03 Type B Mix Design. Apply the mix design specified in 442.02 for a Type A mix except as modified by this subsection:

Modify the Coarse Aggregate Angularity of Table 442.02-1 according to Table 442.03-1.

TABLE 442.03-1 COARSE AGGREGATE ANGULARITY

Lane ADTT	Coarse Aggregate Angularity
<4000	65 [1] /65 [2]
≥4000	75 [1] /70 [2]
[1] Percent fractured (one or more faces) according to ASTM D5821 [2] Percent fractured (two or more faces) according to ASTM D5821	

Ensure that at least 50 percent by weight of virgin fine aggregate is aggregate meeting FAA or is crushed carbonate stone or air-cooled blast furnace slag. Modify the No. 8 (2.36 mm) sieve requirement for a 12.5 mm surface course mix in Table 442.02-2 to 34 to 40 percent. Apply an F-T value of +2 according to 440.04 and 403.06.

442.04 Asphalt Binder. Use a PG 70-22M asphalt binder for surface courses and a PG 64-28 asphalt binder for 19.0 mm intermediate courses. For 12.5 mm intermediate courses use a PG 64-22 asphalt binder for 25 percent or less RAP, and a PG 64-28 asphalt binder for more than 25 percent RAP or if RAS is used with or without RAP.

The minimum total asphalt binder content for a surface course is 5.8 percent. For 12.5 mm intermediate courses, the minimum total asphalt binder content is 5.4 percent and the minimum total virgin asphalt binder content is 3.5 percent. The minimum total asphalt binder content for a 19.0 mm is 4.6 percent.

442.05 Acceptance. The Department will base acceptance of the asphalt concrete mix on the method specified in the Contract line item description (i.e., 446, 447, 448, 449).

442.06 Basis of Payment. Include the cost of asphalt material to coat vertical faces and seal joints and gutters in the contract unit price for Item 442. The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Surface Course, (____mm), Type ____ (___)
442	Cubic Yard (Cubic Meter)	Asphalt Concrete Intermediate Course, (____ mm), Type ___ (___)
442	Cubic Yard (Cubic Meter)	Anti-Segregation Equipment

ITEM 443 STONE MATRIX ASPHALT CONCRETE

443.01 Description
443.02 Quality Control Program
443.03 Composition
443.04 Mixing
443.05 Storage
443.06 Quality Control
443.07 Construction
443.08 Acceptance

443.09 Basis of Payment

443.01 Description. This work consists of design, production, placement, compaction and testing of one or more courses of stone matrix asphalt concrete (SMA), on a prepared foundation. The aggregate and asphalt binder are mixed in a central plant then spread and compacted on the prepared surface. The requirements of 401, 402, 403, 440, 442; and 446 or 447 apply with the additional requirements of this specification.

Do not use the warm mix asphalt method (402.05) for this item.

443.02 Quality Control Program. With the submission of a SMA mix design to be approved, submit to OMM a revised Quality Control Program, if necessary, to include a section to satisfy 403.03.P.

443.03 Composition. Discuss the mix design approach with OMM during the mix design process and prior to submittal.

A. Design Limits. Submit a JMF to the Laboratory which meets the requirements of Table 443.03.1.

TABLE 443.03-1 MIX COMPOSITION

Property Description	Specification
3/4 inch (19.0 mm) [1]	100
1/2 inch (12.5 mm) [1]	85 to 100
3/8 inch (9.5 mm) [1]	50 to 75
No. 4 (4.75 µm0 [1]	20 to 28
No. 8 (2.36 µm) [1]	15 to 24
No. 50 (300 µm) [1]	10 to 20
No. 200 (75 µm) [1]	8 to 12
Binder, % [2]	5.8 to 7.5
VMA, % [3]	16.0 to 19.0
Draindown Test, % [4]	0.3
Design Air Voids, %	3.5
Design Gyrations [5]	65
VCA MIX / VCA DRC [6]	< 1.0
TSR [7]	0.80
F/A	NA

[1] Sieve, percent passing
[2] By total mix
[3] Based on bulk gravity
[4] AASHTO T305 conducted at mix production temperature (not compaction temperature)
[5] Nini and Nmax do not apply
[6] VCA = Volume of Coarse Aggregate (Calculated for mix and dry rodded conditions according to AASHTO R 46.)
[7] Unconditioned specimens will have a minimum 65 psi (450 kPa) retained strength..

Compact specimens at 300 °F (149 °C) for PG 70-22M and 310 °F (154 °C) for PG 76-22M..

B. Coarse Aggregate. Use approved coarse aggregates. Ensure coarse aggregates meet 703.05 and Table 443.03-2.

TABLE 443.03-2 AGGREGATE REQUIREMENTS

Tests	Description	Specification
ASTM D 4791	% Flat and Elongated Ratio at 3:1, (max. to min.) 5:1, (max. to min.)	 20 max 5 max
ASTM D 5821	% Crushed, one / two faces	100 / 90 min
AASHTO T 96	LA Abrasion (stone or gravel)	35 max

C. Mineral Filler. Conform to 703.07. Use mineral filler in the JMF with a plasticity index (AASHTO T 90) not greater than 4 (does not apply to hydrated lime). Reclaimed asphalt concrete pavement passing the 5/8 inch (16 mm) sieve may be used as filler only. Do not account for reclaimed asphalt concrete pavement binder content. Do not use quicklime (CaO). Do not premix filler with another aggregate. Cover mineral filler piles to protect from rain.

Blend the mineral filler, asphalt binder and fiber stabilizer into a homogenous mixture and test the mortar for the following properties of Table 443.03-3.

TABLE 443.03-3 MORTAR TEST REQUIREMENTS

Tests	Description	Specification
AASHTO T315	Unaged DSR, G*/ sin δ (kPa)	5 minimum
AASHTO T315 & T240	RTFO Aged DSR, G*/ sin δ (kPa)	11 minimum
AASHTO R28 & T313	PAV Aged BBR, Stiffness (MPa)	1500 maximum

D. Reclaimed Asphalt Concrete Pavement and Shingles. Do not use reclaimed asphalt concrete pavement except as described in 443.03.C. Do not use reclaimed asphalt shingles.

E. Fiber Stabilizer. Choose and meet the requirements of one of the following fiber stabilizers. Submit with the JMF submittal the fiber manufacturer's most recent actual test data and a certification of compliance for the fiber type to be used. Protect the fiber stabilizer from moisture or other contamination.

1. Cellulose Fibers. Add the fiber at a dosage rate of 0.3 to 0.4 percent by weight of the total mix as directed by District Testing to control draindown in production.

TABLE 443.03-4 CELLULOSE FIBER REQUIREMENTS

Property	Limits
Fiber Length (max)	0.25 inches (6.35 mm)
No. 100 (150 μm) [Alpine Sieve Method, percent passing]	60 to 80
No. 20 (850 μm) [Ro-Tap Sieve Method, percent passing]	80 to 95
No. 40 (425 μm) [Ro-Tap Sieve Method, percent passing]]	45 to 85
No 100 (150 μm) [Ro-Tap Sieve Method, percent passing]	5 to 40
Ash Content	18% non-volatiles (±5%)
pH	7.5 (±1.0)
Oil Absorption (times fiber weight)	5.0 (±1.0)
Moisture Content (max)	5.0%

2. Cellulose Pellets. Cellulose pellets consist of cellulose fiber and may be blended with 0 to 20 percent asphalt binder. Meet the cellulose fiber requirements

above. If no asphalt binder is used, add the pellet at a dosage rate of 0.3 to 0.4 percent by weight of the total mix as directed by District Testing to control draindown in production. Adjust the fiber dosage to maintain the desired fiber amount when fiber is pre-blended with binder.

TABLE 443.03-5 CELLULOSE PELLET REQUIREMENTS

Maximum Pellet size	1/4 cubic inch (4000 mm^3)
Binder	25 to 80 pen.

3. Mineral Fiber. Use mineral fibers made from virgin basalt, diabase, or slag treated with a cationic sizing agent to enhance disbursement of the fiber as well as increase adhesion of the binder to the fiber surface. Add the fiber at a dosage rate of 0.3 to 0.4 percent by weight of the total mix as directed by District Testing to control draindown in production.

TABLE 443.03-6 MINERAL FIBER REQUIREMENTS

Average Fiber length (max)	0.25 in (6.35 mm)
Average Fiber thickness (max)	0.0002 in (0.005 mm)
Shot content (ASTM C612) Percent Passing No. 60 (250 µm) sieve Percent Passing No. 230 (63 µm) sieve	 90 to 100 65 to 100
Degradation (max)[1]	30 percent
[1] (GeorgiaDOT-124/McNett) - copy available from OMM .	

443.04 Mixing. Conform to the following additional requirements.

A. Fiber Stabilizer. Furnish feeder equipment specifically manufactured to uniformly feed fiber into the plant and that is automated through connection with plant controls. Include a low level and no-flow indicator, print out the feed rate of the feeder supply system, and include a transparent pipe section for observing flow consistency. District Testing will approve the fiber feed system prior to the start of production by a trial load of SMA and inspection of the bag house collected material. Conduct and document a weekly quick check of the fiber feed calibration according to the Quality Control Plan. Conduct a daily check of fiber usage by calculating and documenting on the TE 199 that fiber usage is within 10 percent of the intended usage.

In drum plants, add the fibers in loose form, by an automated calibrated feed system, such that the fibers are coated by asphalt binder before being caught in the drum air flow.

In batch plants, distribute the fiber uniformly before injecting asphalt binder and increase mixing time a minimum of 5 seconds.

B. Mineral Filler. Filler may be fed through a hopper if consistency of flow is achieved. If a problem in feeding consistency occurs a pneumatic system will be required. Feed filler into the weigh hopper or pug mill of a batch plant, or at a point away from the flame on a drum plant.

443.05 Storage. Do not store the SMA at the plant for more than 2 hours. Do not exceed a mix temperature of 350 °F (180 °C). If draindown occurs shorten the storage time and increase the fiber dosage.

443.06 Quality Control. Ensure an employee of the Contractor with a Level 3 rating is at the plant or construction site during production of the SMA for any test strips and through at least one full production day satisfactory to the District.

Perform quality control tests every 3 hours of production. The increased frequency of quality control testing may require additional quality control personnel at the plant. Determine the asphalt binder content, gradation, moisture content, air voids, VMA, and MSG of the SMA. For each test series calculate the VCAMIX / VCADRC. If the limit of 1.0 is exceeded stop production until resolved. Perform a draindown test once each day of production and raise fiber dosage 0.1 percent if the test limit is exceeded. Do not exceed the No. 200 (75 µm) sieve design bands by the moving average of three tests. Compact specimens at 300 °F (149 °C) for PG 70-22M and 310 °F (154 °C) for PG 76-22M. Due to sample variability with SMA, a larger than usual sample size from which material is obtained for the various tests is required.

443.07 Construction. At least 24 hours prior to beginning a test strip meet with the Engineer and District Testing and provide a written summary of steps taken to assure mix quality and construction practices account for the special needs of SMA production and placement. Send a copy of the written summary to OMM.

A. Test Strips and JMF Adjustment. Do not begin full production of the SMA until receiving authorization from District Testing. This authorization will be based on the successful construction of one or more test strips. Test strips consist of 50 to 100 tons of SMA produced and placed in accordance with these specifications. Cease SMA production that day unless another test strip is needed. Place test strips in one continuous mat. The test strip will be included in the first lot for determining density for payment.

During the construction of a test strip, perform one set of quality control tests as described above and obtain and test 3 random cores of the compacted pavement. Within 1 working day after a test strip is completed, the Laboratory and the Contractor's Level 3 employee will determine if any changes in the SMA JMF, production, or placement procedures are needed. A redesign of the JMF or another test strip may be required. OMM will notify District Testing of any JMF adjustments. Do not start production until notified by District Testing.

B. Hauling. Provide SMA at a minimum of 300 °F (148 °C) when it arrives at the paver, unless otherwise approved by OMM. If draindown is evident when discharging into the paver, shorten the storage time and increase the fiber dosage.

C. Compaction. Start compaction immediately after the SMA has been placed. Use only steel wheel rollers. Vibratory rollers in vibratory mode, set at a high frequency and low amplitude, can be used as the breakdown roller only. Always operate the breakdown roller immediately behind the paver. If isolated, small fat spots develop, apply sand immediately during compaction. If continuous or large fat spots develop, cease production until resolved. Do not compact SMA that is below 230 °F (110 °C).

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443.08 Acceptance. After accepting the test strips, the Department will base acceptance of the asphalt concrete mix on the method specified in the Contract line item description (i.e., 446 or 447).

443.09 Basis of Payment. Include the cost of asphalt material to coat vertical faces and seal joints and gutters in the contract unit price for Item 443.The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
443	Cubic Yard (Cubic Meter)	Stone matrix asphalt concrete, 12.5mm, PG70-22M, (___)
443	Cubic Yard (Cubic Meter)	Stone matrix asphalt concrete, 12.5mm, PG76-22M, (___)

ITEM 446 ASPHALT CONCRETE CORE DENSITY ACCEPTANCE

446.01 Description
446.02 Joint Construction
446.03 Core Procedures
446.04 Density Acceptance

446.01 Description. This specification describes the acceptance criteria for asphalt concrete surface and intermediate courses using mat and joint cores from each day's production. The Department will base acceptance of the compacted mixture in place on the level of density attained as sampled by the Contractor and analyzed by the Department.

446.02 Joint Construction. Make a hot longitudinal joint between the mainline pavement lane and the adjoining shoulder and all ramps and the adjoining shoulders. If a hot longitudinal joint is specified between the mainline pavement lanes, the Contractor may construct a cold longitudinal joint between the mainline pavement lanes and the adjoining shoulders.

446.03 Core Procedures. Obtain core samples only in the presence of the Engineer and immediately surrender each core sample to the Engineer for testing. If taken, locate cores obtained for Contractor quality control (QC comparison core) longitudinally from and within 4 inches (100 mm) of the Department core. In addition to the QC comparison cores, three extra cores may be taken from the first lot of a JMF for testing to correlate density gauges. Do not take additional cores beyond what is noted above unless clearly identified in the Contractor's QCP.

Clearly label all cores with mat locations so that they may be readily identified. Any unlabeled cores may be destroyed by the Department. Notify the Department if any questions arise. Do not store additional cores anywhere (project, in vehicles or at the plant) beyond those required to be taken for testing.

Test all Contractor cores and maintain records of all tests (core tests and correlated gauge tests) according to the QCP. Destroy all Contractor cores immediately after testing is complete.

Fill core holes by the next workday with asphalt concrete. Before filling, ensure the holes are dry and tack them with asphalt material conforming to 407.02. Properly compact the asphalt concrete used for filling the hole and leave it flush with the pavement.

446.04 Density Acceptance. Obtain ten, 4-inch (100 mm) cores for the Department to test to determine the in-place density of the compacted mixture as a percentage of the average QC Maximum Specific Gravity (MSG) for the production day the material was placed. If Department MSG VA tests show poor comparison to the average QC MSG according to 403.10 use Department determined MSG VA results in the density calculation for each production day.

Payment for compaction of the completed mainline pavement and ramps is by Lot, based upon the degree to which density is attained. Compact shoulders using the same equipment and procedures as used on the mainline pavement. Payment for shoulders depends on the degree to which the density is obtained on the adjacent mainline pavement lane or ramp. However, when a cold longitudinal joint is made between a mainline pavement lane and an adjoining shoulder, payment for the shoulder will be based on the degree to which the density is obtained on the shoulder.

A Lot consists of an area of pavement placed during a production day, including the shoulders. If less than 400 tons (400 metric tons) is produced in a production day, then that production day is combined with the next production day into a single Lot. If greater than 250 tons (250 metric tons) and less than 400 tons (400 metric tons) are produced on the last day of production for the project, then the day's production is a separate Lot. If less than 250 tons (250 metric tons) is produced on the last production day for the project, it is part of the previous Lot for acceptance, provided the previous Lot was placed within 3 days; otherwise, it is a separate Lot.

Within 48 hours after the pavement is placed, obtain ten cores for each Lot at random locations the Engineer determines. The Engineer will divide a Lot into five equal sublots and calculate two random core locations in each sublot as described below using ODOT TE-217 procedure. Both mainline pavement and ramps will be included in Lot determinations. The Engineer will not give the Contractor random core locations early in the Lot placement. The Engineer will tell the Contractor the method used to determine random locations as noted below before project start and will use the same method for all Lots.

Take three cores from cold longitudinal joints (joint cores) and seven cores from the mat (mat cores). If locations not according to this specification are given, immediately inform the Engineer. Do not take joint cores from ramp joints. Take joint cores from the first, last and randomly from one of the three remaining sublots. Determine by random number the longitudinal location of the joint core, and which pavement edge to be cored when the mat placed has both confined and unconfined edges. Take joint cores such that the core's closest edge is 4 inches (100 mm) from the edge of the mat. Obtain the mat cores from at least 12 inches (300 mm) away from the longitudinal joint.

The Department will determine the pay factor for each Lot cored by the pay schedule in Table 446.04-1 for Lots with three cold longitudinal joint cores and Table 446.04-2 for Lots with less than three cold longitudinal joint cores. If less than

10 cores are available for determining the mean, OMM will determine disposition of the Lot.

TABLE 446.04-1 FOR LOTS WITH 3 COLD JOINT CORES

Mean of Cores [1]	Pay Factor	
	Surface Course	Intermediate Course
98.0% or greater	[2]	[2]
97.0 to 97.9%	0.94	[2]
96.0 to 96.9%	1.00	0.94
93.4 to 95.9%	1.04 [4]	1.00
92.4 to 93.3%	1.00	1.00
91.4 to 92.3%	0.98	1.00
90.4 to 91.3%	0.90	0.94
89.4 to 90.3%	0.80	0.88
88.4 to 89.3%	[3]	[3]
Less than 88.4%	[2]	[2]

[1] Mean of cores as percent of average MSG for the production day.

[2] For surface courses, remove and replace. For other courses, the District will determine whether the material may remain in place. If the material may not remain in place, remove and replace this course and all courses paved on this course. The pay factor for material allowed to remain in place is 0.60.

[3] The District will determine whether the material may remain in place. If the material may not remain in place, remove and replace this course and all courses paved on this course. The pay factor for material allowed to remain in place is 0.70.

[4] No incentive will be paid if any single cold joint core is less than 91.0%.

TABLE 446.04-2 FOR LOTS WITH LESS THAN 3 COLD JOINT CORES

Mean of Cores [1]	Pay Factor	
	Surface Course	Intermediate Course
98.0% or greater	[2]	[2]
97.0 to 97.9%	0.94	[2]
96.0 to 96.9%	1.00	0.94
94.0 to 95.9%	1.04 [4]	1.00
93.0 to 93.9%	1.00	1.00
92.0 to 92.9%	0.98	1.00
91.0 to 91.9%	0.90	0.94
90.0 to 90.9%	0.80	0.88
89.0 to 89.9%	[3]	[3]
Less than 89.0%	[2]	[2]

[1] Mean of cores as percent of average MSG for the production day.

[2] For surface courses, remove and replace. For other courses, the District will determine whether the material may remain in place. If the material may not remain in place, remove and replace this course and all courses paved on this course. The pay factor for material allowed to remain in place is 0.60.

[3] The District will determine whether the material may remain in place. If the material may not remain in place, remove and replace this course and all courses paved on this course. The pay factor for such material allowed to remain in place is 0.70.

[4] No incentive will be paid for lots where 3 joint cores are required to be taken but less than 3 cores are taken.

ITEM 447 ASPHALT CONCRETE MAT AND JOINT CORE DENSITY ACCEPTANCE

447.01 Description. This specification describes the acceptance criteria for asphalt concrete surface courses using mat cores from each day's production and joint cores from the completed cold longitudinal paving joints. The Department will base acceptance of the compacted mixture in place on the level of density attained separately in the mat and at the cold longitudinal joints as sampled by the Contractor and analyzed by the Department.

447.02 Joint Construction. Make a hot longitudinal joint between the mainline pavement lane and the adjoining shoulder and all ramps and the adjoining shoulders. If a hot longitudinal joint is specified between the mainline pavement lanes, the

Contractor may construct a cold longitudinal joint between the mainline pavement lanes and the adjoining shoulders. Cold longitudinal joints will be tested according to 447.05.

The Contractor may construct a notched wedge joint for course thicknesses of 1.25 inches (32 mm) or greater. Provide a 0.5 to 0.7 inch (12 to 18 mm) vertical face notch at the upper portion of the wedge after compaction. Allow a notch at the lower wedge toe of height equal to the nominal maximum aggregate size of the asphalt concrete mixture. Provide a sloped wedge with a width of no more than 6.0 inches (152 mm) and an angle of no more than 10 degrees from horizontal for surface courses up to 1.75 inches (45 mm) lift thickness. Provide a sloped wedge with a width of no more than 10.0 inches (250 mm) and an angle of no more than 15 degrees from horizontal for courses over 1.75 inches (45 mm) lift thickness. The lane width is determined from the upper notch of the wedge. When constructing the wedge joint maintain the asphalt material head the same as or greater than the head of asphalt material in front of the spreading equipment screed. Remove any loose asphalt material at the lower wedge toe or any material that is not part of the wedge slope face before overlaying. When the adjacent lane top portion of the wedge joint is placed over the bottom portion of the first lane wedge joint use the same equipment required for constructing wedge joints at 0 degrees wedge taper to achieve pre-compaction of the top portion of the wedge joint.

Do not place a wedge joint at ramps and other tight areas of slow production as designated by the Engineer. Provide a vertical face joint when not constructing a notched wedge joint.

Attach the wedge joint device to the spreading equipment in all wedge joint operations. Ensure the wedge joint device pre-compacts, rather than strikes-off, the asphalt concrete by means of a longitudinal, uniformly decreasing material height of the asphalt concrete forced under the device as the spreading equipment moves forward. Ensure the angle of pre-compaction through the device is 25 to 35 degrees. Ensure the length of travel of material under the device is a minimum of 10 inches (250 mm). Provide additional compaction on the wedge and after the wedge joint device as desired but do not distort the wedge and notch configuration. Ensure the wedge joint device has a variable angle adjustment from 0 degrees (horizontal) to the taper angle necessary to complete the wedge height required as well as creating the required notch. Ensure the wedge joint device is constructed to allow at least the same head of asphalt material in front of the device as is in front of the spreading equipment screed. Ensure the wedge joint device does not allow any asphalt material to bypass wedge joint pre-compaction. Do not use wedge joint equipment unless it has been approved by the Laboratory and meets the above requirements.

Seal all cold longitudinal construction joints by coating the cold joint with certified 702.09 Hot Applied Asphaltic Joint Adhesive to provide 100 percent coverage of the joint face, or wedge and notch, and extend at least 1/2 inch (13 mm) on both surfaces.

447.03 Core Procedures. Obtain core samples only in the presence of the Engineer and immediately surrender each core sample to the Engineer for testing. Do not take additional cores beyond what is required in 447.04 and 447.05 unless clearly identified in the approved Contractor's QCP. If taken, locate cores for the

Contractor's quality control (QC comparison core) longitudinally from and within 4 inches (100 mm) of the random core. In addition to the QC comparison cores, three extra cores may be taken from the first lot of a JMF for testing to correlate density gauges.

Clearly label all cores with mat or joint locations, as applicable, so that they may be readily identified. Any unlabeled cores may be destroyed by the Department. Notify the Laboratory if any questions arise. Do not store additional cores anywhere (project, in vehicles, or at the plant) beyond what is required to be taken for testing.

Test all Contractor cores and maintain records of all tests (core tests and correlated gauge tests) according to the QCP. Destroy all cores immediately after testing is complete.

Fill core holes by the next workday with asphalt concrete. Before filling, ensure the holes are dry and tack them with asphalt material conforming to 407.02. Properly compact the asphalt concrete used for filling the hole and leave it flush with the pavement.

447.04 Mat Density Acceptance. Obtain ten, 4 inch (100 mm) cores for the Department to test to determine the in-place density of the compacted mixture as a percentage of the average QC Maximum Specific Gravity (MSG) for the production day the material was placed. If Department MSG VA tests show poor comparison to the average QC MSG according to 403.10 use Department determined MSG results in the density calculation for each production day.

Payment for compaction of the completed mainline pavement and ramps is by Lot, based upon the degree to which density is attained. Compact shoulders using the same equipment and procedures as used on the mainline pavement. Payment for shoulders depends on the degree to which the density is obtained on the adjacent mainline pavement lane or ramp. However, when a cold longitudinal joint is made between a mainline pavement lane and an adjoining shoulder, payment for the shoulder will be based on the degree to which the density is obtained on the shoulder.

A Mat Density Lot consists of an area of pavement placed during a production day, including the shoulders. If less than 400 tons (400 metric tons) is produced in a production day, then that production day is combined with the next production day into a single lot. If greater than 250 tons (250 metric tons) and less than 400 tons (400 metric tons) are produced on the last day of production for the project, then the day's production is a separate lot. If less than 250 tons (250 metric tons) is produced on the last production day for the project, it is part of the previous lot for acceptance, provided the previous lot was placed within 3 days; otherwise, it is a separate lot.

Within 48 hours after the pavement is placed, obtain ten cores for each Mat Density Lot at random locations the Engineer determines. The Engineer will divide a Lot into five equal sublots and calculate two random core locations in each sublot using an acceptable random number selection method. Both mainline pavement and ramps will be included in Lot determinations. The Engineer will not give the Contractor random core locations early in the Lot placement. The Engineer will tell the Contractor the method used to determine random locations before project start and will use the same method for all Lots. If locations not according to this specification are provided, immediately inform the Engineer.

Take the ten random mat cores such that the core's closest edge is at least twelve inches (300 mm) from the cold longitudinal joint, wedge joint upper notch, or vertical face edge.

The Department will determine the pay factor for each Mat Density Lot cored by the pay schedule in Table 447.04-1. The Department will verify the MTD if the MSG determination has a deviation from the MTD of less than or equal to 0.020. If the MTD is not verified, establish a new MTD according to the procedures established in 403.06. If less than 10 cores are available for determining the mean, the Laboratory will determine disposition of the Lot.

TABLE 447.04-1 MAT DENSITY LOTS

Mean of Cores [1]	Pay Factor Surface Course
98.0% or greater	[2]
97.0 to 97.9%	0.94
96.0 to 96.9%	1.00
94.0 to 95.9%	1.04
93.0 to 93.9%	1.00
92.0 to 92.9%	0.98
91.0 to 91.9%	0.90
90.0 to 90.9%	0.80
89.0 to 89.9%	[3]
Less than 89.0%	[2]
[1] Mean of cores as percent of average MSG for the production day.	
[2] Remove and replace.	
[3] The District will determine whether the material may remain in place. If the material may not remain in place, remove and replace this course. The pay factor for material allowed to remain in place is 0.70.	

447.05. Joint Density Acceptance. A Joint Density Lot will consist of the entire length of eligible cold longitudinal joint on the project. Divide each lot into 2500 foot (760 m) sublots, if the remaining sublot is less than 500 feet (152 m) in length, include that length of longitudinal joint in the previous sublot.

A. Excluded Areas. Do not obtain joint cores from the following excluded joints to determine lot incentive/disincentive payment.

1. Joints where one side of the joint is formed by existing pavement not constructed on the project.

2. Joints within 15 feet longitudinally of an obstruction during construction of the wearing course (manholes, inlet grates, utilities, bridge structures, etc.)

3. Joints where plan material type, thickness, or acceptance method varies from one side of the joint to the other.

4. Joints on ramps.

5. Joints in intersections, gore areas or transitions, or anywhere the Engineer determines paving and phasing methods do not allow for consistent longitudinal joint construction. Prior to paving, submit requests in writing to the Engineer for consideration of any joints to be excluded on this basis. The Engineer will make the final determination.

B. Sampling. Obtain one 6 inch (150 mm) joint density core for each sublot, at the random longitudinal locations as determined by the Engineer. For vertical joints, center joint density cores on the line where the two adjacent mats abut at the surface. For notched wedge joints, center joint density cores one half the joint taper width, away from the joint line in the direction of the wedge. Obtain joint density cores within 48 hours after the longitudinal joint for each sublot is closed. Clearly label all cores so that locations may be readily identified. Identify the samples by Joint Density Lot and Sublot number.

Vertical Joint	Notched Wedge Joint

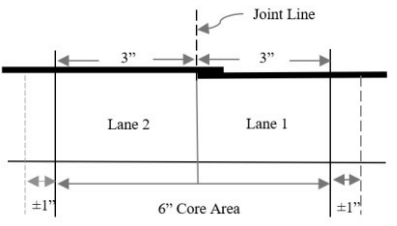
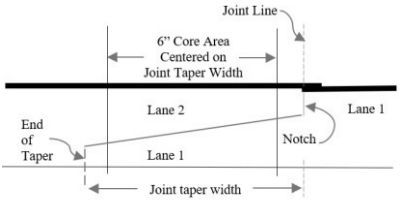

	

Figure not to scale	**Figure not to scale**

C. Percent Within Tolerance (PWT). The Department will average the verified daily MSG average for the mix on each side of the longitudinal joint at each joint density core location according to 447.05. The average of the two values will be used for the density calculation of each sublot sample according to Supplement 1036. Once all test results for the Joint Density Lot have been received, the Department will compute the PWT and average in place density for each lot according to Supplement 1044.

The Department will determine the pay factor for each Joint Density Lot cored by the pay schedule in Table 447.05-1. Lots with all joint cores having a density greater than or equal to 92.0 percent will receive the two percent maximum Joint Density Lot incentive regardless of PWT.

TABLE 447.05-1 JOINT DENSITY LOTS

LOT PWT	Pay Factor Surface Course
PWT ≥ 90	$\left[\frac{(PWT-90)}{10}\times 0.02\right]+1$
PWT = 61 to 89	1.00
PWT = 50 to 60	$1-\left[\frac{(60-PWT)}{10}\times 0.05\right]$
PWT ≤ 49	0.95

The Department will calculate a joint density lot pay factor for each item specified with 447 acceptance. The calculated pay factor adjustment will be applied to all material placed under the corresponding line item specifying 447 acceptance

447.06 Application of Multiple Pay Factors. The Department will apply a mat density pay factor to each Mat Density Lot as defined in 447.04. The Department will apply one joint core density pay factor to all material placed under the corresponding line item of work specifying 447 acceptance as defined in 447.05. The Department will apply mat and joint core density factor to the contract unit bid price for the corresponding line item of work specifying 447 acceptance.

ITEM 448 ASPHALT CONCRETE GAUGE DENSITY ACCEPTANCE

448.01 Description
448.02 Density
448.03 Reports
448.04 Acceptance

448.01 Description. This specification describes the acceptance criteria for asphalt concrete surface and intermediate courses using density gauge and laboratory testing. The Department will determine acceptance of the mixture by Lot, based on the field density and mix composition of random samples taken and tested by the Contractor and verified by the Department.

448.02 Density. Conduct density gauge quality control testing on the asphalt mat according to Supplement 1055. Do NOT enter a density gauge offset of any kind into the gauge. If an offset is already in the gauge remove it. Verify to the Engineer daily that no offset is present in the gauge. All values used in controlling mat density according to Supplement 1055 will be as calculated and written on forms supplied in Supplement 1055.

448.03 Reports. Report density gauge QC testing results according to Supplement 1055.

448.04 Acceptance. Acceptance is by Lot as defined in 403. A Lot is considered acceptable for gradation and asphalt binder content if the deviation of the average

from the JMF and the Range is no more than the tolerances shown in Table 448.04-1.

TABLE 448.04-1 DEVIATION FROM THE JMF AND RANGE TOLERANCES [1]

Mix Property	Deviation from JMF (Percent)	Range (Percent)
Asphalt Binder Content	0.3	1.0
1/2 inch (12.5 mm) sieve	6	15
No. 4 (4.75 mm) sieve	5	15
No. 8 (2.36 mm) sieve	4	15

[1] Based on average of four Lot Acceptance tests.

If the average of the Lot acceptance tests for a particular sieve or sieves, or for asphalt binder content deviates from the JMF by more than the tolerances shown in Table 448.04-1 but falls within the tolerances shown in Table 448.04-2, then the Lot is considered reasonably acceptable and may remain in place with payment at a reduced pay factor as show in Table 448.04-2.

If the Range of the Lot acceptance tests for asphalt binder content or for any particular sieve, or sieves, exceeds the tolerance shown in Table 448.04-1, the Department will apply a pay factor of 0.95.

TABLE 448.04-2 448 ACCEPTANCE SCHEDULE [1]

Mix Property	Pay Factor	2 Tests	3 Tests	4 Tests
Asphalt Binder Content	1.00	0 to 0.47	0 to 0.36	0 to 0.30
	0.98	0.48 to 0.54	0.37 to 0.42	0.31 to 0.35
	0.90	0.55 to 0.61	0.43 to 0.48	0.36 to 0.40
	0.80	0.62 to 0.68	0.49 to 0.54	0.41 to 0.45
	0.60	0.69 to 0.75	0.55 to 0.59	0.46 to 0.50
	[2]	> 0.75	> 0.59	> 0.50
1/2 inch (12.5 mm) sieve	1.00	0 to 8.5	0 to 6.9	0 to 6.0
	0.99	8.6 to 9.9	7.0 to 8.1	6.1 to 7.0
	0.97	10.0 to 11.3	8.2 to 9.2	7.1 to 8.0
	0.94	11.4 to 12.7	9.3 to 10.4	8.1 to 9.0
	0.90	12.8 to 14.1	10.5 to 11.5	9.1 to 10.0
	[3]	> 14.1	> 11.5	> 10.0
No. 4 (4.75 mm) sieve	1.00	0 to 7.1	0 to 5.8	0 to 5.0
	0.99	7.2 to 8.5	5.9 to 6.9	5.1 to 6.0
	0.97	8.6 to 9.9	7.0 to 8.1	6.1 to 7.0
	0.94	10.0 to 11.3	8.2 to 9.2	7.1 to 8.0
	0.90	11.4 to 12.7	9.3 to 10.4	8.1 to 9.0
	[3]	> 12.7	> 10.4	> 9.0
No. 8 (2.36 mm) sieve	1.00	0 to 5.7	0 to 4.6	0 to 4.0
	0.99	5.8 to 7.1	4.7 to 5.8	4.1 to 5.0
	0.97	7.2 to 8.5	5.9 to 6.9	5.1 to 6.0
	0.94	8.6 to 9.9	7.0 to 8.1	6.1 to 7.0
	0.90	10.0 to 11.3	8.2 to 9.2	7.1 to 8.0
	[3]	> 11.3	> 9.2	> 8.0

[1] Based on average of Lot Acceptance tests from the JMF.
[2] Remove and replace material
[3] Engineer will determine if the material may remain in place. Pay factor for material allowed to remain in place is 0.70.

The Department will determine payment for the Lot by multiplying the contract unit price by the pay factor. When any pay factors for a specific Lot are less than 1.00, use the lowest pay factor to calculate the payment.

The Department will base acceptance of partial Lots on the average and the Range of the results of tests on the number of samples obtained

Payment for compaction of the completed pavement is based on quality assurance (QA) testing according to Supplement 1055. Each QA density test represents one half (1/2) day's production. The Department will use Table 448.04-3 to determine the percent deduction pay adjustment due to density for each one half (1/2) day's production represented by the QA test.

TABLE 448.04-3 DENSITY PAY DEDUCTIONS

Density (%)	Payment Deduction	
	One Test Below 91.0%	Both Tests Below 92.0%
91.0 to 91.9	n/a	5%
90.0 to 90.9	5%	10%
89.0 to 89.9	15%	15%
88.0 to 88.9	30%	30%
Less than 88.0	Remove and replace	

ITEM 449 ASPHALT CONCRETE NON-DENSITY ACCEPTANCE

449.01 Description. This specification describes the non-density acceptance criteria for asphalt concrete surface, intermediate, and base courses. The Department will determine acceptance of the mixture based on the required roller coverage.

449.02 Rollers. Use only steel wheel and pneumatic tire types of rollers meeting the minimum requirements of the following tables. Conform to manufacturer's specifications for all ballasting.

TABLE 449.02-1 ROLLER CAPACITY

Roller Type	Maximum Capacity square yards per hour (m^2/hr)
Tandem	700 (600)
Three-Wheel	700 (600)
Trench	15 per inch width (13 per 25 mm width)
Pneumatic Tire, Type I	1000 (850)
Pneumatic Tire, Type II	700 (600)
Vibratory, Vibrating Roll	15 per inch width (13 per 25 mm width)
Vibratory, Static Roll (not vibrating)	3 per inch width (3 per 25 mm width)

TABLE 449.02-2 STEEL WHEEL ROLLERS

Roller Type	Three-Wheel	Tandem	Vibratory Static	Trench
Total weight, tons (metric tons)	10 (9)	8 to 12 (7 to 11)	8 to 12 (7 to 11)	
Compression rolls, pounds per inch width (kN/m), minimum	300 (53)	200 (35)	120 (21)	300 (53)

TABLE 449.02-3 PNEUMATIC TIRE ROLLERS

Type I	
Tire size, minimum	9.00 × 20 in (229 × 508 mm)
Wheel load, minimum	5000 lb. (2250 kg)
Average tire contact pressure, minimum	85 psi (590 kPa)
Type II	
Tire size, minimum	7.50 × 15 in (191 × 381 mm)
Wheel load, minimum	2000 lb. (900 kg)
Average tire contact pressure, minimum	55 psi (380 kPa)

For pneumatic tire rollers, use self-propelled, reversible units with vertical oscillation on all wheels on at least one axle. Determine the tire inflation pressure necessary to meet the specified minimum contact area and contact pressure requirements. Furnish the tire manufacturer's charts or tabulations to the Engineer for verification of the required inflation pressure. Check tire inflation pressure as the Engineer directs and maintain it within 5 pounds per square inch (35 kPa) of the required pressure.

449.03 Compaction. Immediately after spreading the asphalt concrete and adjusting any surface irregularities, compact the mixture uniformly using rollers conforming to 449.02. Do not use a spreading rate that exceeds the total of the specified capacities of the rollers in use. However, if compacting a mixture spread 1 inch (25 mm) thick or less, do not use a spreading rate that exceeds twice the total capacity of the rollers in use.

Coordinate the spreading of the mixture with the required roller coverage, considering the rate of cooling of the mixture as affected by lift thickness and environmental conditions. Complete the required roller coverage during the time in which the temperature of the mixture is sufficient for the roller coverage to be effective in compacting the mixture.

Compact base mixtures using a combination of both steel wheel and Type I pneumatic tire rollers; however, in small areas, compact these mixtures as the Engineer approves using any of the rollers specified in 449.02.

Use a minimum of two rollers when compacting surface mixtures placed 1 inch (25 mm) thick or less.

Compact variable depth courses using a combination of both steel wheel and pneumatic tire rollers; however, in small areas, compact these mixtures as the Engineer approves using any of the roller types specified in 449.02.

For surface courses using a polymer modified asphalt binder give a copy of the JMF approval letter containing the design compaction temperature to the Engineer before any mix is placed. Unless otherwise specified ensure that the mix temperature immediately before rolling is not less than 290 °F (145 °C) if placing hot mix asphalt, and not less than 250 °F (121 °C) if placing warm mix asphalt according to 402.05. Do not compact polymer asphalt concrete surface courses with pneumatic tire rollers.

Use steel wheel rollers to remove any surface deviations and deformations caused by pneumatic tire rollers. Do not use pneumatic tire rollers if any resultant surface deformations cannot be removed.

Do not use vibratory rollers on courses with a thickness under 1 1/4 inches (32 mm).

449.04 Acceptance. Mixes will be accepted as follows:

A. Acceptance of 301, 302, and 424 Type A Mixes. Acceptance is based on Table 449.04-1.

TABLE 449.04-1 MIX ACCEPTANCE

	Deviation from JMF[1]	Range
Asphalt Binder Content	±0.5%	1.0
No. 4 (4.75mm) sieve	±6%	12
[1] Based on the average of the day or night QC Tests		

B. Acceptance of All Other Mixes. Acceptance is by Lot as defined in 403. A Lot is considered acceptable for gradation and asphalt binder content if the deviation of the average from the JMF and the Range is no more than the tolerances shown in Table 449.04-2.

TABLE 449.04-2 DEVIATION FROM THE JMF AND RANGE TOLERANCES [1]

Mix Property	Deviation from JMF (Percent) [1]	Range (Percent)
Asphalt Binder Content	0.3	1.0
1/2 inch (12.5 mm) sieve	6	15
No. 4 (4.75 mm) sieve	5	15
No. 8 (2.36 mm) sieve	4	15
[1] Based on average of four Lot Acceptance tests.		

If the average of the Lot acceptance tests for a particular sieve or sieves, or for asphalt binder content deviates from the JMF by more than the tolerances shown in Table 449.04-2, but falls within the tolerances shown in Table 449.04-2, then the

Lot is considered reasonably acceptable and may remain in place with payment at a reduced pay factor as show in Table 449.04-3.

If the Range of the Lot acceptance tests for asphalt binder content or for any particular sieve, or sieves, exceeds the tolerance shown in Table 449.04-2, the Department will apply a pay factor of 0.95.

TABLE 449.04-3 ACCEPTANCE SCHEDULE [1]

Mix Property	Pay Factor	2 Tests	3 Tests	4 Tests
Asphalt Binder Content	1.00	0 to 0.47	0 to 0.36	0 to 0.30
	0.98	0.48 to 0.54	0.37 to 0.42	0.31 to 0.35
	0.90	0.55 to 0.61	0.43 to 0.48	0.36 to 0.40
	0.80	0.62 to 0.68	0.49 to 0.54	0.41 to 0.45
	0.60	0.69 to 0.75	0.55 to 0.59	0.46 to 0.50
	[2]	> 0.75	> 0.59	> 0.50
1/2 inch (12.5 mm) sieve	1.00	0 to 8.5	0 to 6.9	0 to 6.0
	0.99	8.6 to 9.9	7.0 to 8.1	6.1 to 7.0
	0.97	10.0 to 11.3	8.2 to 9.2	7.1 to 8.0
	0.94	11.4 to 12.7	9.3 to 10.4	8.1 to 9.0
	0.90	12.8 to 14.1	10.5 to 11.5	9.1 to 10.0
	[3]	> 14.1	> 11.5	> 10.0
No. 4 (4.75 mm) sieve	1.00	0 to 7.1	0 to 5.8	0 to 5.0
	0.99	7.2 to 8.5	5.9 to 6.9	5.1 to 6.0
	0.97	8.6 to 9.9	7.0 to 8.1	6.1 to 7.0
	0.94	10.0 to 11.3	8.2 to 9.2	7.1 to 8.0
	0.90	11.4 to 12.7	9.3 to 10.4	8.1 to 9.0
	[3]	> 12.7	> 10.4	> 9.0
No. 8 (2.36 mm) sieve	1.00	0 to 5.7	0 to 4.6	0 to 4.0
	0.99	5.8 to 7.1	4.7 to 5.8	4.1 to 5.0
	0.97	7.2 to 8.5	5.9 to 6.9	5.1 to 6.0
	0.94	8.6 to 9.9	7.0 to 8.1	6.1 to 7.0
	0.90	10.0 to 11.3	8.2 to 9.2	7.1 to 8.0
	[3]	> 11.3	> 9.2	> 8.0

[1] Based on average of Lot Acceptance tests from the JMF.
[2] Remove and replace material
[3] Engineer will determine if the material may remain in place. Pay factor for material allowed to remain in place is 0.70.

The Department will determine payment for the Lot by multiplying the contract unit price by the pay factor. When any pay factors for a specific Lot are less than 1.00, use the lowest pay factor to calculate the payment.

The Department will base acceptance of partial Lots on the average and the Range of the results of tests on the number of samples obtained.

450 RIGID PAVEMENT

ITEM 451 REINFORCED PORTLAND CEMENT CONCRETE PAVEMENT

451.01 Description. This work consists of constructing a pavement composed of reinforced portland cement concrete on a prepared surface.

451.02 Materials. Furnish materials conforming to:

Concrete,
either Class QC 1P, QC MS,.....499
* Class RCA .....Supplement 1117
Joint sealer.....705.04
Preformed filler.....705.03
Curing materials.....705.05, 705.06, 705.07 Type 2
Tiebar steel, epoxy coated.....709.00
Reinforcing steel 709.09, 709.10, 709.12
Dowel bars and basket assemblies 709.07, 709.13

* Use of Recycled Concrete aggregate as part of a concrete mix can be accepted with conformance to Supplement 1117

451.03 Pavement Quality Control. When the concrete pavement bid item includes "with QC/QA", provide complete quality control of the concrete manufacturing, placing and curing operations and quality control testing of the work

conforming to 455. The Engineer will review and accept the plan prior to beginning of any paving operations.

When the concrete pavement bid item includes "with QC/QA" the Engineer will

451.04 Equipment. Furnish self-propelled spreading and finishing machines capable of consolidating and finishing the concrete and producing a finished surface meeting the requirements specified. Ensure that all paving equipment is operated in a manner that does not result in segregation of the mixture or loss of air entrainment in the mixture.

Construct mainline pavement using slip form paving in accordance with 451.04 A.

Construct small, short sections, or irregular pavement areas, as determined by the Engineer, in accordance with 451.04 B.

Construct ramps and secondary roads in accordance with 451.04 C.

A. Slip Form Construction. Place concrete using an industry-standard slip form paver designed to spread, consolidate, screed, and finish the freshly placed concrete in one complete pass of the machine and with a minimum of hand finishing providing a dense and homogeneous pavement.

Consolidate the full width and depth of concrete pavement placed by a single pass of approved internal vibrators. Operate the vibrators at a frequency range of 7000 to 11,000 impulses per minute. Attach vibrators to either the spreading or finishing equipment in such a manner that they do not come in contact with preset dowel basket assemblies, the subgrade, reinforcing mesh, or side forms. Do not operate vibrators in a manner to cause a separation of the mix ingredients (segregation); i.e., either a downward displacement of large aggregate particles or an accumulation of laitance on the surface of the concrete. Avoidance of segregation may require reduction in the vibration frequency within the range specified when forward motion of the paver is reduced. Connect the power to all vibrators so they stop when the machine motion is stopped. Stop paving operations if any vibrator fails to operate within the above specified range.

Provide an electronic monitoring device that displays the operating frequency of each internal vibrator when paving mainline, ramps, acceleration/deceleration lanes, and collector distributor lanes. Ensure the monitoring device has a readout display near the paver operator's controls visible to the operator and the Engineer. Operate the monitoring device continuously while paving and display all vibrator frequencies with manual or automatic sequencing among individual vibrators. Using the monitoring system, record the following minimum information: time of day, station location, paver track speed, and the frequency of each individual vibrator. Make recordings after each 25 feet (8 m) of paving or after 5-minute intervals of time. If not using a monitoring system with a recorder, make and record readings every 30 minutes. Provide vibration data, in electronic format, to the Engineer prior to the next concrete placement.

Electronic vibration monitoring devices are not required for paving machines used to construct gores. When electronic monitoring devices are not required, use a

tachometer or similar device to demonstrate to the Engineer the paving equipment vibration meets specification.

Operate the slip form paver with as nearly a continuous forward movement as possible. Coordinate all operations of mixing, delivering, and spreading concrete to provide uniform progress with minimal stopping and starting of the paver. If for any reason it is necessary to stop the forward movement of the paver, immediately stop the consolidation devices. Unless controlled from the machine, do not apply any other tractive force to the machine.

Accurately control the finish grade of the pavement from a pre-set grade line parallel to the finish grade. Use equipment with controls that will trace the grade line and automatically adjust the grade of the screed.

In areas where adjoining concrete pavement is to be constructed, ensure that the surface at the edge of the pavement on either side of the longitudinal joint does not vary more than 1/4 inch (6 mm) below the typical section. Ensure that the outside edges of the pavement do not vary more than 1/2 inch (13 mm) below the typical section. Ensure that all pavement edges are nearly vertical with no projections or keyways exceeding 1/2 inch (13 mm).

In the area of construction joints placed at the end of the days run, the Engineer will allow a reduction of approximately 2 inches (50 mm) in overall width.

B. Fixed Form Construction. Spread, screed, and consolidate concrete using one or more machines between previously set side forms. Furnish an adequate number and capacity of machines to perform the work at a rate equal to the concrete delivery rate. Furnish machines capable of uniformly distributing and consolidating the concrete without segregation. Do not use vibrating truss screeds or roller screeds.

Provide machines capable of operating on two side forms, on adjacent lanes of pavement and one side form, or on two adjacent lanes as necessary. When placing concrete adjacent to an existing pavement lane, take measures to protect the adjacent pavement from damage. Remove from the work any machine that causes displacement of the side forms from the line or grade or causes undue delay, as determined by the Engineer, due to mechanical difficulties.

Finish small areas, irregular areas, and areas that are inaccessible to finishing equipment using other methods as approved by the Engineer. Accomplish vibration of these areas using hand held or machine mounted internal vibrators. Continue vibration to achieve adequate consolidation, without segregation, for the full depth and width of the area placed.

Use straight edge side forms made of steel and of a depth equal to the specified pavement thickness. Use modified steel forms if a safety edge is required. Do not use bent or damaged side forms or forms with damaged joint locks or pin pockets. Provide forms in sections of not less than 10 feet (3 m) in length without horizontal joints in the height of the form. Utilize forms with a nominal base width of at least 3 inches (75 mm). Ensure forms can support the paving equipment without shifting or deforming during paving. Clean and oil all forms each time they are used. If the

radius of the circular pavement edge is 100 feet (30 m) or less, use flexible or curved forms of a design acceptable to the Engineer. Provide adequate devices to securely set forms and withstand operation of the paving equipment. Do not use built-up forms except to construct pavement of a specified thickness whose total area for the project is less than 2000 square yards (1650 m^2). Provide forms with adequate joint locks to tightly join ends of abutting form sections together.

C. Ramps and Secondary Roads. Place concrete lanes with a minimum length of 400 LF and constant width using an industry-standard slip form paver or fixed form paver designed to spread, consolidate, screed, and finish the freshly placed concrete in accordance with 451.04 A. or 451.04 B. A minimum pavement length does not include variable widths or widened sections.

Place concrete pavement lengths with less than 400 LF using alternate methods.

For areas determined to be inaccessible to industry-standard slip form pavers or fixed form pavers provide a detailed layout of the areas with sufficient information detailing the paving equipment inaccessibility along with the specifications of the proposed alternative finishing equipment for approval by the Engineer.

Accomplish vibration of any areas that are placed using alternative finishing equipment using hand held or machine mounted internal vibrators. Continue vibration to achieve adequate consolidation without segregation for the full depth and width of the area placed.

451.05 Setting Forms. Set all forms in conformance to the required grade and alignment. Ensure the entire length of the forms is supported on thoroughly compacted material for the entire operation of placing and finishing the concrete. Set side forms with the top face of the form varying not more than 1/8 inch in 10 feet (3 mm in 3 m) from true plane, and the vertical face varying not more than 1/4 inch in 10 feet (6 mm in 3 m) from true plane. Test the forms for variations from the above requirements and reset as necessary. Do not use loose earth, pebbles, etc., to shim the forms. Immediately before placing concrete, the Engineer will approve the alignment and grade of all forms set.

451.06 Fine Grading of Subgrade or Subbase.

A. Fixed Form Construction. After side forms have been set to line and grade and securely fastened, use a subgrade or subbase planer to remove a slight amount of material and bring the surface to final grade and a smooth dense condition. Check the subgrade or subbase using a multiple pin template operated on the forms or other methods approved by the Engineer. Correct and retest all high or low spots.

Instead of the above operation, the Contractor may place forms on subgrade or subbase prepared according to 451.06.B.

B. Slip Form Construction. After the subgrade or subbase is placed and compacted to the required density, use an automatic subgrading machine to cut the areas for pavement and the areas that will support the paving machine to the plan elevation. Construct the grade sufficiently in advance of placing the concrete to permit the Engineer to check the grade.

451.07 Placing Concrete. When constructing on subgrade or subbase, immediately before placing concrete, bring the surface to a thoroughly moistened condition by sprinkling with water as directed by the Engineer.

When constructing on asphalt concrete, coat the surface with curing membrane at least one day prior to placing concrete. Apply the curing membrane at a minimum rate of 1 gallon (1 L) for each 150 square feet (3.7 m^2) of surface treated using an approved self-propelled mechanical sprayer. Provide an adequate shield to protect the fog spray from the wind. Thoroughly agitate the curing material before use.

Deposit concrete on the grade in a manner that requires as little rehandling as possible. Do not allow workers to walk in the freshly mixed concrete unless wearing clean boots or shoes, free of earth or any foreign material.

When using dowel basket assemblies, place concrete in such a manner that the assemblies are not disturbed. Do not allow concrete to discharge onto any dowel basket assembly unless the hopper is well centered on the assembly. Use a separate internal vibrator to consolidate concrete around dowel basket assemblies.

Do not operate mechanical equipment other than saws on newly placed concrete pavement prior to opening to traffic according to 451.17. If only finishing equipment is carried on an existing lane, paving may be permitted after that lane has been in place for at least 3 days and after specimen beams shall have attained a modulus of rupture of 500 psi (3.5 MPa).

When the width of pavement being placed in one operation is 12 feet (3.6 m) or more and the total area of any given width of pavement on the project exceeds 10,000 square yards (8300 m^2), use a separate standard manufacture, self-propelled concrete placer/spreader that receives concrete into a hopper adjacent to the area to be paved, delivers the concrete in front of the slipform paver, and uniformly spreads the concrete at the proper thickness for the full width being paved. When a slipform paver is equipped with a dowel bar inserter, the separate placer/spreader requirement may be waived provided the concrete is delivered in front of the slipform paver at a consistent and uniform thickness for the full width being paved and the slipform paver is capable of spreading, consolidating, screeding, and float finishing the freshly placed concrete. Provide the Engineer documentation that the slipform paver will meet this specification.

Do not mix, place, or finish concrete after dark without operating an adequate and approved lighting system.

When the air temperature is 40 °F (4 °C) or below, ensure the concrete has a temperature of between 50 and 80 °F (10 and 27 °C) at the point of placement.

When the air temperature is greater than 40 °F (4 °C) before placing, maintain a concrete temperature of not more than 95 °F (35 °C). Ensure that the concrete maintains a minimum temperature of 40 °F (4 °C) until the concrete reaches a minimum modulus of rupture of 600 psi.

Do not place concrete on any surface that is frozen or has frost.

Make two test beams from each 7500 square yards (6300 m^2) of concrete or fraction thereof incorporated in the work each day. Construct and test concrete beams for modulus of rupture according to Supplement 1023.

451.08 Placing Reinforcement. Place pavement mesh of the size and at the locations within the concrete slab shown on the standard construction drawings. When placing reinforced concrete pavement in two layers, strike off the entire width of the bottom layer to a length and depth that allows laying the mat of reinforcement on the concrete and in its final position without further manipulation. After installing reinforcement directly upon the concrete, place, strike off, and screed the top layer of concrete. When reinforced concrete pavement is placed in one layer and in advance of placing concrete, position and securely anchor the reinforcement to the underlying base or pavement. As an alternative, after spreading the concrete and while it is in a plastic condition, use mechanical or vibratory means to place reinforcement in the concrete.

Where reinforcement is overlapped, securely fasten mats of reinforcement together at the edges of the sheets and at two additional points along the lap. Use reinforcing steel free from dirt, oil, paint, and grease.

451.09 Joints. Unless otherwise directed, construct all transverse contraction and construction joints normal to the centerline of the pavement lane and of the type, dimensions, and at locations specified. Construct contraction joints by saw cutting. Saw contraction joints across the full pavement width for a continuous joint and match previously placed lanes.

Construct longitudinal joints between simultaneously placed lanes by sawing.

Accurately mark the pavement with the correct locations of all joints to be saw cut. Ensure the method of marking remains clearly visible after the paver passes and until the joint saw cut is completed. Reapply curing compound according to 451.11 at saw cut joints.

Use either a standard water-cooled, diamond-bladed concrete saw or an early-entry, dry cut, light-weight concrete saw. Provide saws with adequate guides, blade guards, and a method of controlling the depth of cut. After wet sawing, clean the joint using a jet of water. After dry sawing clean the joint using air under pressure. Maintain a standby saw in working condition and an adequate supply of blades.

When using standard concrete saws, and for pavement less than or equal to 10 inches (255 mm), saw joints to a minimum depth of one-fourth the specified pavement thickness. For pavements greater than 10 inches (255 mm) thick, saw joints to a minimum depth of one-third the specified pavement thickness. Saw joints 1/4 ± 1/16 inch (6 ± 1.6 mm) wide measured at the time of sawing.

When using early-entry saws use saw blades and skid plates as recommended by the saw manufacturer for the coarse aggregate type being used in the concrete. Saw joints 1/8 inch (3 mm) wide and 2 1/4 to 2 1/2 inches (56 to 63 mm) deep.

Repair all cracking or spalling according to 451.17.

A. Longitudinal Joint. Place deformed epoxy coated steel tiebars, epoxy coated hook bolt with epoxy coated coupling, or epoxy coated hook bolt alternate (wiggle bolt) with epoxy coated coupling, in longitudinal joints during consolidation of the

concrete. Install them at mid-depth in the slab using approved mechanical equipment. As an alternate procedure, rigidly secure them on chairs or other approved supports to prevent displacement. Provide tie bars, hook bolts, or wiggle bolts of the size and spaced as shown on the standard construction drawings. If used, securely fasten hook bolts or wiggle bolts with couplings to the form at the longitudinal construction joint as shown on the standard construction drawings.

B. Transverse Joints. For all transverse joints, install round, straight, smooth, steel dowel bars of the size shown in Table 451.09-1.

TABLE 451.09-1 DOWEL SIZE

Thickness of Pavement	Solid Dowel Diameter	Tubular Dowel	
		Outside Diameter	Wall Thickness
Less than 8 1/2 inches (215 mm)	1 inch (25 mm)	-	-
8 1/2 to 10 inches (215 to 255 mm)	1 1/4 inches (32 mm)	1 5/16 inches (33 mm), or 1 3/8 inches (35 mm)	0.120 inches (3 mm)
Over 10 inches (255 mm)	1 1/2 inches (38 mm)	1 5/8 inches (41 mm)	0.120 inches (3 mm)

Ensure each end of tubular dowel is fitted with a snug fitting plug style insert cap that does not exceed the outside diameter of the tubular dowel, to prohibit any intrusion of concrete or other materials.

Within 2 hours prior of placing concrete coat the full length of all dowels with a thin uniform coat of new light form oil as a bond-breaking material.

1. Load Transfer Assemblies.

Use load transfer (dowel basket) assemblies in transverse contraction joints conforming to and placed according to the standard drawings to hold the dowels in a position parallel to the surface and centerline of the slab at mid-depth of the slab thickness.

Preset all dowel basket assemblies before the day's paving unless the Engineer determines complete presetting is impractical.

Immediately before paving check that the assemblies are held firmly in place and check that the dowels are parallel to the grade and parallel to centerline of pavement.

For each load transfer assembly, provide a continuous assembly between longitudinal joints or between the longitudinal joint and pavement edge. Drive at least eight 1/2-inch (13 mm) diameter steel pins a minimum of 18 inches (460 mm) long at an angle to brace the assembly from lateral and vertical displacements during the placing of concrete. Drive two of these pins opposite each other at each end of the assembly, and drive the remaining pins in staggered positions on each side of the assembly. Where it is impractical to use the 18-inch (460 mm) length pins, such as where hardpan or rock is encountered, and provided the assembly is held firmly, the Engineer may authorize use of shorter pins. Where the dowel basket assembly is placed on material that may allow settlement or distortion, anchor the assembly with a combination of pins and steel plates, or by some other means satisfactory to the Engineer to prevent settlement.

When concrete pavement is placed on an existing concrete pavement or on a stabilized base, secure dowel basket assemblies from lateral and vertical displacement during concrete placement using power-driven fasteners and appropriate clips or pins driven in predrilled holes of a diameter slightly less than the pin diameter. Use either of the above methods or a combination of the two in sufficient numbers to adequately secure the basket assemblies.

Where widths other than 12 feet (3.6 m) are specified, the Contractor may use standard dowel basket assemblies with dowel spacings adjusted as follows. Maintain 6-inch (150 mm) dowel spacing at the longitudinal joint and increase the spacing at the outer edge of the lane up to 12 inches (300 mm). Where an odd width of lane occurs and if the standard dowel basket assembly would provide for a space exceeding 12 inches (300 mm), place a dowel 6 inches (150 mm) from the outer edge of the lane. Hold such a dowel rigidly in proper position by a method satisfactory to the Engineer or cut and splice a dowel basket assembly of greater length than required to attain the required length.

2. Slip Form Paver with Mechanical Dowel Bar Inserter.

The Contractor may propose to use a slip form paver with mechanical dowel bar inserter (DBI) to place dowels in transverse contraction joints the full thickness of pavement and spaced according to the standard construction drawings. Submit details and specifications of the proposed equipment to the Engineer at least 14 calendar days prior to mobilizing the equipment to the project.

The use of any slip form paver with DBI is allowed only after acceptable performance is demonstrated with a test section and approved by the Engineer. Continued verification during all contract paving is required for each production day as detailed below.

Provide all equipment, perform all testing, and evaluate the slip form paver with DBI as detailed in the following sections.

a. MIT Scan-2 Equipment and Reporting

Provide MIT Scan-2 equipment to determine the location of dowel bars in either fresh or hardened concrete including horizontal translation, longitudinal translation, vertical translation, horizontal skew, vertical tilt, and cover.

Provide equipment for determining dowel bar alignment that has an onboard computer that runs the test; collects and stores the test data on a memory card; performs the preliminary evaluation; and provides a printout of results immediately after scanning. Provide a copy of MagnoProof or other required software to the Engineer to analyze equipment data and generate a detailed report of all required alignment parameters in an Excel and a graphical color representation.

Ensure the equipment is properly calibrated conforming to the manufacturer's specifications and for the specific project conditions. Provide calibration documentation to the Engineer prior to the start of construction. Establish a standard protocol for scanning direction.

Provide trained personnel to operate the equipment and documentation of training prior to start of construction.

Provide a print out, at the time of scanning, for horizontal translation, longitudinal translation, vertical translation, horizontal skew, vertical tilt, and cover for each bar in each joint scanned. For each Test Section and daily, for each day of production, provide a complete report to the Engineer at the completion of scanning along with a digital copy of all data collected in the manufacturer's native file format as well as all calibration files. Include the standard report generated using the MagnoProof software in Excel format and with color graphical representation of each joint. Include in the report: project contract number, county-route-section, placement date, scan date, station location and lane, joint ID number, name of operator, and all required alignment parameters.

If non-magnetic dowel bar materials are to be used, propose and demonstrate alternative measurement equipment to the Engineer showing capability to provide measures equal or similar to the acceptance and rejection criteria of Table 451.09-2. Obtain the Engineer's approval of alternative equipment prior to paving. If no alternative equipment can demonstrate the required capability, do not use the slip form paver with DBI.

Prior to paving, review the measurement equipment applicability for the project conditions with the Engineer, including: ambient moisture conditions, dowel material, metallic concrete aggregate and potential contributors to magnetic interference (presence of tiebars, reinforcing steel or other embedded or underlying steel items that may affect measurement accuracy). Establish how the measurement device can meet the project conditions. If the measurement device cannot meet the project conditions, do not use the slip form paver with DBI.

b. Acceptance/Rejection

The required dowel bar tolerances are given in Table 451.09-2. Dowel bar alignment is measured as detailed below. Any dowel bar exceeding any Acceptance Tolerance in Table 451.09-2 is considered misaligned. Rejection Criteria is in absolute inches.

TABLE 451.09-2

INDIVIDUAL DOWEL BAR ALIGNMENT TOLERANCES

Alignment Parameter	Acceptance Tolerance (inches)	Rejection Criteria (inches)
Horizontal Translation[1]	±2.0	±3.0
Longitudinal Translation [2]	±2.0	±4.0
Vertical Translation [3]	±1.0	± T/6
Horizontal Skew [4]	±0.60	±1.0
Vertical Tilt [5]	±0.60	±1.0
Cover [6]	-	2.5 minimum

[1] Horizontal Translation - the total difference, measured horizontally, between the actual dowel bar location and the plan required dowel bar location along the transverse contraction joint.

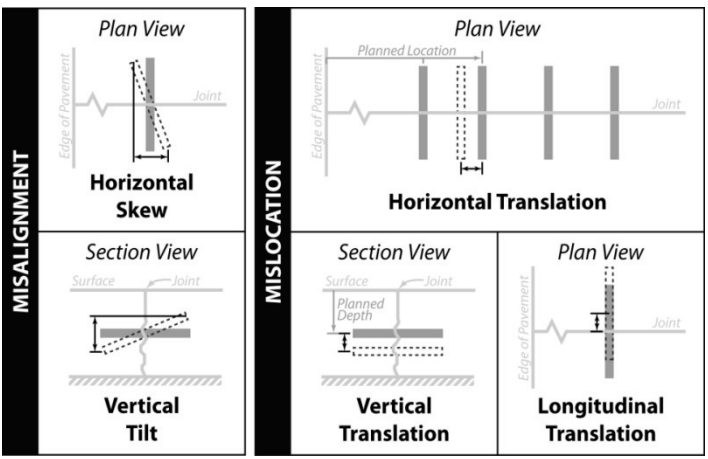
[2] Longitudinal Translation - the total difference, measured in the longitudinal direction, from the center of the transverse contraction joint to the actual dowel bar center. Also termed as "side shift".

[3] Vertical Translation - the total difference, measured vertically, between the centerline of the actual dowel bar location and the mid-depth of the slab. (T = Pavement Thickness in inches)

[4] Horizontal Skew - the total difference, measured from end to end of a dowel bar, of the dowel in the horizontal plane.

[5] Vertical Tilt - the total difference, measured from end to end of a dowel bar, of the dowel bar in the vertical plane.

[6] Cover - the least distance between the surface of embedded reinforcement and the outer surface of the concrete.



Perform a Joint Score Analysis conforming to CPTP Tech Brief Best Practices for Dowel Placement Tolerances (FHWA-HIF-07-021) for every joint. Joint Score is a measure of the combined effects of horizontal skew and vertical tilt. To calculate the Joint Score: calculate the Single Dowel Misalignment (SDM) by the square root of the sum of the squares of the Horizontal Skew and Vertical Tilt of each dowel in the joint; determine the weighing factor (W) for each bar from Table 451.09-3; sum the W values for every dowel in the joint and add one (1).

$$Single\ Dowel\ Misalignment\ (SDM) = \sqrt{(Horizontal\ Skew)^2 + (Vertical\ Tilt)^2}$$

Joint Score (JS) – Evaluated for a single transverse joint between adjacent longitudinal joint(s) and/or pavement edge(s) (i.e., a typical 12 ft [3.6 m] standard lane or up to 14 ft [4.3 m] widened lane), and calculated as:

$$Joint\ Score\ (JS) = 1 + \sum_{i=1}^{n} W_i$$

Where:

n = number of dowels in the single joint

Wi = weighting factor (Table 451.09-3) for dowel i

TABLE 451.09-3

WEIGHTING FACTORS IN JOINT SCORE (JS) DETERMINATION

Single Dowel Misalignment (SDM)	W, Weighting Factor
SDM ≤ 0.6 in. (15 mm)	0
0.6 in. (15 mm) < SDM ≤ 0.8 in. (20 mm)	2
0.8 in. (20 mm) < SDM ≤ 1 in. (25 mm)	4
1 in. (25 mm) < SDM ≤ 1.5 in. (38 mm)	5
1.5 in. (38 mm) < SDM	10

Joint Score Trigger (JST) – A scaling of the Joint Score risk value to account for the actual number of dowels required in a single joint for pavement width other than 12 ft (3.6 m), calculated as:

$$Joint\ Score\ Trigger\ (JST) = 10 * \frac{\#\ of\ Dowel\ Bars\ in\ Single\ Joint}{12}$$

Include the Joint Score and Joint Score Trigger for every joint scanned in the report to the Engineer. Any joint with a Joint Score equal to or greater than the Joint Score Trigger is considered locked and rejectable.

3. Test Section

Prior to production use of a DBI slip form paver, perform at least a 500-foot (150 m) long test section for acceptance of the machine. Measure the alignment and location of each dowel bar in the test section using the MIT Scan-2. The test section will be considered acceptable if the following acceptance criteria are met:

a. Each Joint Score (JS) is less than Joint Score Trigger (JST);

b. Ninety percent (90%) of the dowel bars meet the Acceptance Tolerances of Table 451.09-2;

c. None of the dowels exceed the Rejection Tolerances of 451.09-2.

If the test section acceptance criteria are not met, use the data to refine the paving process and reduce/eliminate misalignments and mislocations. Modify,

repair or replace any slip form paver with DBI that does not meet the acceptance criteria and perform another test section. Do not begin production paving until the slip form paver with DBI test section acceptance criteria are met.

Perform corrective action of all joints in the test section according to Section 5 below.

Perform a new test section for any new slip form paver with DBI that will be used for any contract item of work.

Perform a new test section at the beginning of every construction season; after major paver maintenance/repairs; at mobilization or remobilization to a project, for major concrete mix design changes or different concrete mix designs; and as required by Section 4 of this specification.

If the length of the section to be paved makes it unreasonable to perform the test section, scan all joints for conformance with the requirements of Section 2, Acceptance/Rejection. Correct any joints with dowels found to be rejectable or JS greater than JST according to Section 5, Corrective Action.

Determine during the test section if embedded tiebars are affecting the Rejection Tolerances and JS's. If the test section demonstration shows interference, exclude from the JS and JST calculations any dowel bar(s) closer than 12 in. (300 mm) in any direction to tiebars in the longitudinal joint(s). At the Engineer's discretion, establish the location of excluded dowels by another equivalent non-destructive method or by probing.

4. Paving Quality Control Testing (QCT) for Dowel Bar Inserters

When using the accepted slip form paver and DBI for any contract item of work, perform quality control scans with the MIT-Scan 2 equipment at the following minimum:

a. Measure the alignments and location for every 10th joint and calculate the JS and JST for each measured joint. Acceptable QCT is when all measures are within the acceptance tolerances in Table 451.09-2 and JS is less than JST.

i. When the daily QCT finds more than 10 percent of the joints scanned have dowels exceeding the acceptance tolerances of Table 451.09-2 but the JS is less than the JST, increase the scanning frequency to every 5th joint. Evaluate the paving process to reduce/eliminate misalignments and mislocations and continue to pave. The QCT frequency will revert to every 10th joint when two consecutive days of scanning every 5th joint show no dowels exceeding the acceptance tolerances of Table 451.09-2 and all JSs are less than the JST.

ii. When QCT finds any individual dowel bars exceeding the rejection criteria of Table 451.09-2 or the JS is found to exceed the JST, the joint is considered to be locked and immediate investigation needs to be made as follows:

1. Scan joints in front and behind the locked joint location until five (5) consecutive joints in both directions are found with no dowel bars exceeding the rejection criteria of Table 451.09-2 and no JS is found to exceed the JST.

2. If the additional scanned joints show no additional dowel bars exceeding the rejection criteria of Table 451.09-2 and no JS exceeding the JST, evaluate equipment to determine what caused the original problem. Before continuing paving increase the frequency of QCT to conform to 4.a.i.

3. If the additional scanned joints show additional dowel bars exceeding rejection criteria of Table 451.09-2 or joints with a JS exceeding the JST, stop paving. Investigate to determine the cause of the dowel bar rejection issues and provide the causes and alternative corrections to the Engineer.

The Engineer will determine if the corrections will correct the problem and may allow paving to temporarily continue to validate if the corrections work. During any evaluation, scan all joints to determine if the corrections were successful. If successful, continue QCT scanning at the frequency of 4.a.i. If not successful, discontinue paving, repair or replace the slip form paver and DBI, and repeat the Test Section

b. All dowel bars found beyond rejection criteria of Table 451.09-2 or joints with a JS exceeding the JST require a corrective action proposal conforming to Section 5, Corrective Action.

Provide report formats as described in Section 1, MIT Scan-2 Equipment and Reporting.

5. Corrective Action

Submit a proposal for corrective action to the Engineer for any dowel that exceeds the rejection criteria in Table 451.09-2 or any joint that has a JS greater than the JST. As a minimum, include the following in the corrective action proposal:

1. Locations of rejectable dowels with identification information as described in Section 1, MIT Scan-2 Equipment and Reporting.

2. Locked joint identification information as described in Section 1, MIT Scan-2 Equipment and Reporting.

3. Proposed method of remediation for each identified location, including supporting documentation of the effectiveness of the means of proposed remediation.

The Department may not require corrective action for random dowels that exceed the rejection criteria of Table 451.09-2 depending on location; what alignment parameter was the cause for the rejection; and the frequency of the rejectable dowels.

The Department may not require corrective action for all JS exceeding the JST, if they are random in nature. Up to two (2) consecutive joints with a JS exceeding the JST may be accepted, provided that the adjacent three (3) joints before or after do not have dowels exceeding Table 451.09-2 rejection limits and have JS's less than the JST. The Department will require corrective action where there are more than two (2) consecutive joints with a JS exceeding the JST.

Do not proceed with any corrective action until the Engineer approves the proposed method(s) of correction.

C. Expansion Joints. Where a pressure relief joint is not provided adjacent to a bridge structure, construct expansion joints at the first two regularly spaced transverse contraction joint locations adjacent to the bridge approach slab on each side of the bridge. If the pavement is constructed in two or more separately placed lanes, construct the transverse expansion joints in a continuous line for the full width of the pavement and shoulders.

Construct expansion joints according to the standard construction drawings. Install the face of the expansion joint perpendicular to the centerline except when expansion joint is installed at a skewed bridge approach slab.

Use round, straight, smooth, steel dowels, and within 2 hours prior to placing concrete, coat the dowels with a thin uniform coat of new light form oil as a bond-breaking material to provide free movement. After coating the dowel, install a sleeve of metal or other approved material approximately 3 inches (75 mm) long, with crimped end, overlapping seams fitting closely around the dowel, and a depression or interior projection to stop the dowel a sufficient distance from the crimped end to allow 1 inch (25 mm) for longitudinal dowel movement with pavement expansion on one free end of each dowel. If approved by the Engineer, use other means to allow for 1 inch (25 mm) of expansion.

Punch or drill proper size dowel holes into the preformed expansion joint filler to ensure a tight fit around each dowel.

Form a 1-inch (25 mm) wide and 1-inch (25 mm) deep opening on top of the expansion joint filler and seal this opening with 705.04 joint sealers.

D. Construction Joints. Install dowelled construction joints at the end of each day's work and when work is suspended for a period of more than 30 minutes.

Use dowels in transverse construction joints. Within 2 hours prior to placing concrete, coat the free half of all dowels with a thin uniform coat of new light form oil. Use an adequate bulkhead, with openings provided for dowel bars spaced as specified and shaped to fit the typical section of the pavement, to form a straight joint. During placing of concrete, hold dowels rigidly in position.

Locate construction joints at or between contraction joints. If located between contraction joints, construct the construction joint no closer than 10 feet (3 m) to the last contraction joint.

451.10 Finishing. Use 10 foot (3 m) straightedges to continually check the finished concrete surface for trueness. If the pavement surface is dragged with a diagonal pipe float machine, occasionally check the surface while the concrete is plastic. Finish the concrete to the required cross section to minimize or eliminate hand finishing operations. Do not add water to aid finishing.

Before the concrete initially sets, round the edges of the pavement along each side of each slab and on each side of transverse expansion joints to the radius specified using an approved edging tool. Before texturing the surface, eliminate tool marks left by the edging tool.

Texture the surface in the longitudinal or transverse direction using a broom to produce a uniform, gritty, texture. Immediately following the broom drag texture, tine the pavement in the longitudinal direction using an approved device that

produces uniform tine spacing 3/4 inches (19 mm) apart, 1/8-inch deep (3 mm) and 1/8-inch wide (3 mm). Do not tine within 3 inches (75 mm) of pavement edges or longitudinal joints. Only use equipment that will tine the full width of the pavement in one operation and uses string line controls for line and grade to assure straight tining texture.

Use transverse tining in small areas only with the approval of the Engineer. Use equipment that produces a random pattern of grooves [0.05 inch (1.3 mm) to 0.08 inch (2.0 mm) deep and 0.10 inch (3 mm) wide] spaced at 3/8 to 1-3/4 inches (10 to 45 mm), with 50 percent of spacings less than 1 inch (25 mm). Transverse tining may be used as an option for shoulders of main line or shoulders of ramps and gore areas. Tine all mainline shoulders or all ramp shoulders in a consistent direction if choosing this option. Request the use of transverse tining and identify the locations, at least one week prior to paving, for approval by the Engineer.

Demonstrate to the Engineer methods to ensure the groove depth meets this specification.

Before the concrete finally sets, impress complete station numbers into the pavement every 100 feet (50 m), e.g., 1+00 (2+050). Mark station equations in the pavement as shown on the plans. Ensure that the numerals are 3 to 4 inches (75 to 100 mm) high and 1/4 inch (6 mm) deep. Place the station numbers parallel with and facing the right edge of the pavement, and centered 12 inches (0.30 m) in from the right edge. On divided highways, provide station numbers on both pavements. When placing concrete shoulders with the traveled lane, place station numbers 12 inches (0.30 m) in from the outside edge of the shoulder and facing the pavement.

451.11 Curing. Immediately after the finishing operations have been completed and after all free water has dissipated, spray and seal all exposed concrete surfaces with a uniform application of curing membrane in such a manner as to provide a continuous uniform film (equal to a white sheet of typing paper), without marring the surface of the concrete. Apply a minimum of 1 gallon (1 L) of material for each 150 square feet (3.7 m^2) of surface treated using an approved self-propelled mechanical sprayer. Provide an adequate shield to protect the fog spray from the wind. Before each use, thoroughly agitate the curing material.

On pavement with integral curb or small and irregular areas that are inaccessible to the mechanical spray machine, apply the curing material by a hand-held sprayer.

As soon as the forms have been removed, immediately correct all honey-comb areas and coat the edges of the pavement with the curing material as described above.

Respray all areas of curing material film damaged during the sawing of joints.

The Contractor may water cure concrete with wet burlap cloth, waterproof paper, or polyethylene sheeting. Apply curing as soon as possible and without marring the concrete surface. Unless the specimen beams have attained a modulus of rupture of 450 psi (3.1 MPa) keep the entire surface of the top and sides of the newly placed concrete covered for seven days. Protect concrete from freezing until beams attain a strength of 600 psi (4.2 MPa).

The above requirements for curing are minimum requirements only. Repair or replace all concrete showing injury or damage due to insufficient curing at no additional cost to the Department.

451.12 Removing Forms. Remove forms in a manner that doesn't damage the pavement.

451.13 Surface Smoothness. After final concrete curing and cleaning the pavement surface, test the pavement surface for smoothness using a 10-foot (3 m) rolling straightedge. Provide a two or four-wheeled device with an indicator wheel at the center that detects high and low areas in the pavement surface. Provide equipment that actuates a pointer scale, issues an audio alert, or marks the pavement with paint or dye when encountering any high or low areas in excess of a preset tolerance. Tow or walk the rolling straightedge over the completed pavement. Test all wheel paths in the presence of the Engineer. Locate wheel paths parallel to the pavement centerline and approximately 3 feet (1 m) measured transversely from the center of the lane. Maintain alignment of the rolling straightedge with reference to the pavement edge at all times. Other devices such as approved profilers conforming to Supplement 1058 and using ProVAL software may be used with approval of the Engineer.

Correct all surface variations so indicated to within the specified tolerance and in a manner that provides a surface texture conforming to 451.10. For corrective grinding provide equipment conforming to 451.14. Ensure pavement surface variations do not exceed 1/8 inch in a 10 foot (3 mm in a 3 m) length of pavement. For ramp pavements and for those pavements with curvature greater than 8 degrees, or with grades exceeding 6 percent, ensure the surface variations do not exceed 1/4 inch in 10 feet (6 mm in 3 m).

Repair or replace sections of pavement containing depressions that cannot be corrected by grinding as directed by the Engineer.

451.14 Profile Grinding. To correct surface variations exceeding tolerances specified in 451.13 use grinding equipment conforming to Item 257.

451.15 Pavement Grooving Corrections. When pavement tining locations are found out of conformance with 451.10 correct the tining using power driven, self-propelled machines specifically designed to groove concrete pavement with diamond impregnated blades or diamond impregnated cylinder rings. Furnish blades or cylinder rings mounted on an arbor head so that the resulting grooves comply with 451.10. Furnish grooving equipment with a depth control device that will detect variations in the pavement surface and enable adjustment of the cutting head to maintain the specified groove depth.

If a pavement area was diamond ground that area does not require tining restoration conforming to 451.10.

Vary from these requirements only for small areas and only with written permission from the Engineer.

451.16 Sealing Expansion Joints. As soon as feasible after completing sawing, but before the pavement is open to construction equipment and traffic, seal expansion joints with material conforming to 705.04. Just before sealing, thoroughly

clean each joint of all foreign material, using approved equipment. Ensure the joint faces are clean and dry when the seal is installed.

451.17 Opening to Traffic. When 7 days have elapsed, the Contractor may use the completed pavement for traffic, including construction traffic. If a modulus of rupture of 600 psi (4.2 MPa) has been attained, the Contractor may open the pavement to traffic when 5 days have elapsed. If necessary to open a portion of the pavement in less than 5 days, with the proviso that the pavement will be cured for a minimum of 3 days, use a high early strength concrete composed of additional 701.04 or 701.05 cement, or non-chloride accelerating admixture to obtain a modulus of rupture of 600 psi (4.2 MPa) in 3 days or less.

Pavement Repairs before Department Acceptance. Remove and replace, or repair diagonal cracks; longitudinal cracks; transverse cracks; spalled pavement surfaces, and any pavement panels with cement balls or mud balls; as approved by and at no cost to the Department. Do not repair single hairline transverse cracks in the middle third of panels with reinforcing conforming to BP-1.1. Submit a repair plan with the location, type of repair, materials to be used and procedures to the Department for approval. Do not perform any repairs without Department approval.

The Engineer may approve repair of isolated transverse or diagonal cracks with a full depth repair according to Item 255 and applicable standard construction drawings. Repair cracks by replacing the pavement the full width between longitudinal joints, perpendicular to the centerline and at least 6 feet (1.8 m) longitudinally. Install smooth dowel bars at the interface between the original pavement and the replaced pavement section. Locate and size the repairs to ensure that the repair limits are at least 7 feet (2.1 m) away from any transverse joint.

The Engineer may approve repair of isolated longitudinal cracks within 15 inches (380 mm) of a tied longitudinal joint by routing and sealing the crack according to Item 423. For other longitudinal cracks, repair the same as for transverse or diagonal cracks stated above.

The Engineer may approve repair of isolated spalled pavement with Item 256 Bonded Patching of Portland Cement Concrete Pavement.

Repair all cement balls or mud balls by coring out the area full depth with a diamond core bit and replacing the removed concrete with the same concrete as in the pavement. Remove and replace any pavement panel with 5 or more cement balls or mudballs. Locate the limits of the repair along the longitudinal joints and at least 1 foot (0.3 m) past the transverse joints to remove any existing dowel bars. Install smooth dowel bars at the transverse limits of the repairs. Install Type D (Drilled Tied Longitudinal) Joint along the longitudinal limits.

451.18 Pavement Thickness and Concrete Strength.

A. Thickness. As determined by measurement of cores cut as specified in this section, construct the concrete not more than 0.2 inch (5 mm) less than the specified thickness. Core pavement at the direction of the Engineer and at locations the Engineer determines according to Supplement 1064. Provide a 4-inch diameter core specimen for measurements.

For the purpose of coring, the Department will consider the entire pavement area of a specified thickness a lot. To determine the number of cores, each lot will be divided into sublots. A sublot consists of 2000 square yards (1650 m2) of a pavement lot or major fraction thereof.

Take one random core for each sublot but not less than 3 cores for any pavement lot cored. If a core shows a deficiency in thickness of more than 1/2 inch (13 mm) from the specified thickness, take additional cores to determine the limits of the deficiency. Follow the procedures below:

1. Take a core 5 feet (1.5 m) longitudinally on both sides of the deficient core. If both the cores are less than 1/2-inch (13 mm) deficient in thickness, the zone of deficiency has been determined.

2. If either or both 451.18.A.1 cores are more than 1/2 inch (13 mm) deficient in thickness, cut a core 50 feet (15 m) longitudinally from the deficient core(s). If the 50 foot (15 m) core(s) is more than 1/2 inch (13 mm) deficient, cut additional cores at 100 foot (30 m) longitudinal intervals until a core is less than 1/2 inch (13 mm) deficient; until the pavement ends; or until overlapping an adjacent pavement sublot's core in the same lane.

3. If a pavement sublot has cores more than 1/2 inch (13 mm) deficient in thickness and the sublot's constructed width is greater than 12 feet (3.6 m) obtain cores transverse to the location of the deficient cores. Obtain transverse cores at a location 1/2 the distance from the deficient core to the furthest edge of pavement. Obtain a transverse core for each core more than 1/2 inch (13 mm) deficient.

4. The Engineer will use the cores that measure less than 1/2 inch (13 mm) deficient in thickness to define the limits of the deficiency.

If any deficient core is greater than 1 inch (25 mm) deficient in thickness determine the limits of over 1 inch (25 mm) deficiency by following 451.18.A.1 through 4 to determine the limits. Remove and replace those areas greater than 1 inch (25 mm) deficient in thickness.

The Engineer will calculate average thickness of concrete pavement placed as follows:

When zones of deficient thickness greater than 1/2 inch (13 mm) to 1 inch (25 mm) are allowed to remain in place, the Engineer will calculate two average thicknesses. A Project Average Thickness (PAT) including all cores not more than 1/2 inch (13 mm) deficient. Cores that exceed the specified thickness by more than 1/2 inch (13 mm) will be considered as the specified thickness plus 1/2 inch (13 mm) when calculating the PAT. A second Deficient Zone Average (DZA) will include all cores with thickness deficiency greater than 1/2 inch (13 mm) to 1 inch (25 mm). The pavement represented by each of the two averages, PAT or DZA, will be calculated and paid separately.

The Engineer will determine and apply deductions to each separately placed width of pavement.

For any pavement areas removed and replaced, re-core those areas following this section of the specifications. Include those core values into the calculations for the PAT or DZA as applicable.

Unless the Director requests, do not core any widening less than 5 feet (1.5 m) in width or any pavement area less than 2000 square yards (1650 square meters).

Fill all core holes with concrete of the same proportions and materials used in the pavement.

B. Strength. Use the thickness core from each pavement sublot to determine compressive strength. Provide a 4 inch diameter specimen for strength testing

For concrete pavement bid items "with QC/QA", the AASHTO accredited laboratory will test the QC cores for compressive strength according to ASTM C 42. Test the QC cores between 28 and 90 days of age. Notify the Engineer when the QC cores will be tested.

The Engineer will require one QA core for every 10 sublots for verification testing of compressive strength. Obtain the QA core from the same location as the QC core tested for compressive strength. At least one QA core will be required per lot. Provide the QA cores to the Engineer for testing at District Testing. Notify the Engineer of the date that the corresponding QC core will be tested. The QA cores will be tested on the same date. The Engineer will verify the QC cores versus the QA cores according to 455.

Calculate an average and standard deviation for each lot according to Supplement 1127. Determine the pay factors according to Table 451.19-2.

Do not calculate an average and standard deviation for high-early strength concrete QC cores. Determine the pay factors for individual sublots according to Table 451.19-2.

For concrete pavements bid items "without QC/QA", the Department will perform the strength testing. Provide the Engineer with the cores for strength testing. Pay factors for sublot cores will be calculated based on the pay factors in Table 451.19-2.

451.19 Price Adjustments. Payment will be made at the unit bid price upon completion of any section of pavement. Final pay adjustments to the bid price will be made upon completion of the pavement operations and all thickness, strength, and smoothness data is tabulated and pay adjustments applied according to 451.19.A through 451.19.D.

A. Pavement Thickness. Price adjustments for thickness deficiencies will be calculated according to Table 451.19-1

TABLE 451.19-1

CONCRETE PAVEMENT THICKNESS PAY FACTOR (PF_T)

Deficiency in Thickness as Determined by Cores	Proportional Part of Contract Price
0.0 to 0.2 inch (0.0 to 5 mm)	100 percent
0.3 to 0.5 inch (6 to 13 mm)	$Ratio\left[\frac{PAT}{PST}\right]^6$
0.6 to 1.0 inch (15 to 25 mm)*	$Ratio\left[\frac{DZA}{PST}\right]^6$
Greater than 1.0 inch (25 mm)	Remove and replace

* The DCA will determine whether pavement areas from 0.6 inch (15 mm) to 1 inch (25 mm) deficient in thickness will be allowed to remain in place at the reduced price or must be removed and replaced.

PAT = Project Average Thickness

PST = Plan Specified Thickness

DZA = Deficient Zone Average

B. Concrete Strength. Record the compressive strength results for each sublot of concrete. Calculate the pay factor for each JMF separately.Determine the strength pay factor according to Table 451.19-2.

TABLE 451.19-2

CONCRETE PAVEMENT STRENGTH PAY FACTOR

Design Strength = f'c from 499 or as per plan
Individual Sublot Core Strength = x
Project Average Strength ($\bar{x}$) = $\sum_1^n x \div n$
Project Standard Deviation (δ) = $\sqrt{\sum(x-\bar{x})^2/(n-1)}$
Project Required Strength (f'cr) = f'c + 1.65 δ
Strength Pay Factor (PF_S) = $\bar{x}$ / f'cr *
* When PF_S is greater than 1.00, pay the unit bid price

C. Pavement Smoothness. When the Project plans include Proposal Note 420 determine a lump sum payment adjustment following the requirements of Proposal Note 420.

D. Multiple Deficiencies. When a pavement exhibits multiple deficiencies for thickness and strength, the reduced unit price will be calculated for each deficiency and the lowest reduced unit price will be used. Adjustment for smoothness under 451.19.C will conform to the lump sum requirements of 451.19.C.

451.20 Method of Measurement. The Department will measure Reinforced Concrete Pavement by the number of square yards (square meters) completed and accepted in place. The width equals the pavement width shown on the typical cross-section of the plans plus additional widening as the Engineer directs in writing. The width of any safety edge is not included in the pavement width measurement. The Department will field measure the length along the centerline of each roadway or ramp. The Department will determine the area based on the above width and length.

451.21 Basis of Payment. Payment is full compensation for furnishing and placing all materials including reinforcing steel, dowels, and joint materials; for furnishing the 10 foot (3 m) rolling straightedge; and for coring and testing the pavement. For pavement found deficient in thickness or compressive strength, the Department will pay a reduced price according to 451.19.

The Department will not pay extra for pavement with an average thickness in excess of that shown on the plans.

The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
451	Square Yard	Reinforced Concrete Pavement Class ____
	(Square Meter)	
451	Square Yard	Reinforced Concrete Pavement Class ____
	(Square Meter)	with QC/QA

ITEM 452 NON-REINFORCED PORTLAND CEMENT CONCRETE PAVEMENT

452.01 Description. This work consists of constructing a non-reinforced portland cement concrete pavement on a prepared surface.

452.02 Construction. The requirements of Item 451 apply, except as follows.

Do not comply with the requirements of 451.08.

Provide dowels at transverse contraction joints in mainline pavement, ramps, acceleration/deceleration lanes, or collector/distributor lanes. Dowels for contraction joints in concrete shoulders on mainline pavement, ramps, acceleration/deceleration lanes, or collector/distributor lanes are not required unless the contraction joint is located within 500 feet (150 m) of a pressure relief joint.

Space contraction joints according to the standard construction drawings. If Item 452 pavement is specified for shoulders and is tied longitudinally to Item 451 or 305 pavement, match the joints in the shoulder pavement to the spacing and alignment of the adjacent pavement.

Do not place construction joints within 6 feet (1.8 m) of another parallel joint.

If making pavement repairs before Department acceptance under 451.17, repair all cracks exclusive of size or location

452.03 Method of Measurement. The Department will measure Non-Reinforced Concrete Pavement by the number of square yards (square meters) completed and accepted in place. The width equals the pavement width shown on the typical cross-sections of the plans plus additional widening as the Engineer directs in writing. The Department will field measure the length along the centerline of each roadway or ramp.

452.04 Basis of Payment. Payment is full compensation for furnishing and placing all materials, for surface testing, and for coring the pavement.

For pavement found deficient in thickness or compressive strength, the Department will pay a reduced price according to 451.19.

The Department will not make additional payment over the contract unit price for any pavement with an average thickness in excess of that shown on the plans.

The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
452	Square Yard (Square Meter)	Non-Reinforced Concrete Pavement, Class _____
452	Square Yard (Square Meter)	Non-Reinforced Concrete Pavement, Class _____ with QC/QA

ITEM 455 QUALITY CONTROL PLAN, TESTING AND ASSURANCE FOR QC/QA CONCRETE

455.01 General. Use this specification for items 451, 452, 305 and 511 when the bid item description requires QC/QA. This specification defines the minimum Quality Control Plan (QCP) requirements, the Contractor's minimum quality control (QC) materials testing and the Department's quality assurance (QA) materials verification testing requirements.

Develop a QCP to assure that all materials and construction practices for the item will conform to the specifications. Establish the responsibilities, duties and frequency for both in-process controls and quality control testing at the concrete's source and at the job site.

455.02 Quality Control Plan Basic Requirements. Submit a complete QCP that includes, at a minimum, the following:

A. Basic Information. Provide the following information:

1. The name and location of the Department inspected and approved concrete producer.

2. The Department accepted Job Mix Formula (JMF) to be used for each item.

3. The name and accreditation of the AASHTO accredited laboratory to be used for testing fresh and hardened concrete properties for structures or pavements. Provide notification to the Department immediately when there is a change in accreditation status.

4. Name of the person(s) who is responsible for compliance with the QCP; acts as liaison to the Department; remains at the placement until the placement of concrete is completed and curing has been applied; reports any non-specification test results and assures that adjustments are made to remedy problems.

5. Names of all technicians from the AASHTO accredited laboratory who will perform project site inspection, sampling and testing. Provide additional technician names when plant sampling and testing is also required. Use ACI certified Concrete Field Testing Technicians - Grade I to perform concrete sampling and testing. Provide copies of their ACI certificates.

6. Names of all technicians from the AASHTO accredited laboratory who will perform compressive strength testing. Use ACI certified Concrete Strength Testing Technicians to perform compressive strength testing. Provide copies of their ACI certificates.

7. Calibration records of test equipment to be used on the project.

8. Develop and provide example forms for reporting QC test results to the Engineer conforming to 455.03.C or 455.04.G.

B. Minimum Quality Control at the Concrete Source. Address how the following items will be controlled in the QCP:

1. Verify that the material sources are certified for the type of work in which they are to be used.

2. Verify that aggregates, cementitious materials and admixtures sources and design weights match the proposed JMF.

3. Describe how aggregates will be hauled, stockpiled and handled to minimize segregation, avoid contamination, and assure a uniform gradation.

4. Describe procedures and frequency used to control and measure aggregate moistures.

5. Provide the batching sequence and mixing procedures to be used to assure that material balling does not occur.

6. Describe how adjustments to the SSD aggregate design weights in the JMF are made to compensate for moisture contained in the aggregates during batching.

7. Describe how adjustments to mix water will be made to compensate for aggregate moistures to assure the JMF's water-cementitious ratio (W/Cm) is not exceeded.

8. Define how the batching tolerances of 499.06 are assured.

9. Provide the information reported on the batch ticket and how it will be validated to meet the requirements of 499.07.

10. Describe the method and frequency of assuring that the combined aggregate gradation remains within Zone II of the Coarseness Factor Chart. If adjustments are made to the JMF proportions, provide the individual aggregate gradations, combined aggregate gradation, and verification that the proportions remain within Zone II of the Coarseness Factor Chart to the Engineer prior to placement.

11. If using a non-potable water source, describe the procedures and frequency to verify that the water meets the requirements of ASTM C1602.

a. If a reclaiming system is used, describe the method and frequency of testing to ensure that the water contains no more than 0.06% chlorides.

12. Describe how and when the water is removed from the mixer prior to batching a new load of concrete.

13. Describe methods to verify that the storage and dispensing methods for the admixtures comply with the manufacturer's recommendations.

14. Describe methods to keep the concrete temperature within specifications and how to mitigate effects of changes to the set time.

15. Define the desired slump and tolerance for concrete in each construction item.

455.03 Additional Quality Control Plan Requirements for Structures. In addition to basic QCP minimum requirements of 455.02, provide the following for structures:

A. Material Quality Control Requirements. Provide the following controls for the concrete materials:

1. Divide the concrete for the project into lots and sublots and define the placement sequence for each work item as follows:

a. Division of Lots. A lot consists of concrete of the same JMF. Divide lots by substructure and superstructure items. Include approach slab concrete with the superstructure lot. Combine structural components requiring the same class of concrete with different reference numbers into a single lot. However, one exception is a slipformed parapet may be considered separately from a bridge deck of same class of concrete.

b. Division into QC Sublots. Divide each lot into sublots of not more than 50 yd^3 (40 m^3) for obtaining QC samples. In no case should there be less than 3 sublots in a lot. The Engineer will approve the sublot division.

2. Determine and define the sampling location based on placement method (i.e. pumping, tremie, direct chute deliver, etc.).

a. Define in the QCP plan equipment and methods to be used for 455.03.A.3.b.

3. Perform the following Quality Control testing for air content and slump at a minimum:

Air Content. Sample the concrete to perform the QC testing at the point of placement. Use the following quality control procedures during placement:

a. Sample and test the air content on at least the first three (3) loads of concrete delivered for each day's placement. Ensure the air content is within the specified parameters in Table 499.03-1 prior to extending the testing frequency to each sublot.

b. For concrete delivered to the point of placement by means of pumping equipment, describe the methods that will be used to provide back-pressure in the system in order to minimize the amount of air loss and maintain a continuous flow of concrete in the pipe lines and boom during the pumping operation. Obtain concrete samples at the point of placement without interrupting the continuous flow of concrete by either passing the pump line over a sampling container or obtain a composite sample from five different portions of the deposited concrete prior to vibration. Sample and test the air content at the point of placement for the first three (3) loads to ensure that it is within the specified parameters in Table 499.03-1 prior to extending the frequency to each sublot.

c. When the Engineer determines concrete cannot feasibly be sampled at the point of placement, provide a trial placement of concrete to verify that the air content is within the limits of Table 499.03-1.

If a load of concrete is tested and found to have an air content beyond the limits of Table 499.03-1, do not accept and place that load unless it can be adjusted to be within the specified limits. Do not adjust the air content using a defoaming agent.

Notify the Engineer and test at least the next three loads for air content to ensure that the results are again within the limits of Table 499.03-1. The sampling frequency may then be extended back to one test for every sublot.

Slump. Perform slump testing at the point of discharge when strength specimens are obtained. Ensure that the slump is within the specified parameters of Table 499.03-3.

4. Establish who is responsible for reporting air and slump results to the Engineer within 1 day after each placement.

5. Describe the methods for initial curing, transporting, curing, testing and reporting test results of the QC compressive strength specimens to the Engineer within five (5) days or the completion of testing.

a. Define the unique sample identification and tracking method of concrete specimens.

6. QC Compressive Strength Testing. Perform QC sampling for compressive strength, at the point of discharge for each sublot from the load randomly determined by the Engineer. The Contractor may sample at the point of placement if air content exceeds the limits of Table 499.03-1 at the point of discharge.

For each sublot make one (1) set of three (3) – 4 x 8 inch (100 x 200 mm) QC compressive strength cylinders. Perform all required making, curing, transporting, capping and testing of the samples to conform to the applicable ASTM specifications.

Have the AASHTO accredited laboratory perform the compression testing on the cylinders.

7. Field Cured Strengths. Determine whether field cured cylinders, beams or maturity curve acceptance will be used for 511.13 and 511.14 strength testing. Define how many cylinders or beams will be made per placement.

a. Field Cured Samples. Describe the methods for transporting, testing and reporting the test results of field cured samples for falsework removal and opening to traffic.

b. Define the reporting methods to be used to keep the Engineer informed that field cured strength results conform to the requirements for construction, falsework removal and opening to traffic.

If developing a maturity curve, provide the maturity curve to the Engineer with the QCP conforming to Supplement 1098.

B. Construction Process Quality Control Requirements. In addition to the requirements of 455.02, Provide the following for the construction processes:

1. Establish and define in the QCP the minimum required rate of concrete delivery for continuous placement for each construction item; determine if the plant capacity is capable of providing the concrete at the established rate; and determine how many trucks will be used to provide the concrete at the specified rate of delivery.

2. Describe the procedures and equipment to be used for delivering and placing concrete for each item; methods of consolidating, finishing and grooving the concrete; and methods of curing the concrete.

3. Describe methods and frequency of assuring the grade, super elevation, slab thickness, reinforcing steel cover, etc. meets the plan dimensions.

4. Establish the orientation of the finishing machine on a skewed superstructure to conform to 511.07.

5. Describe the methods to be used to meet cold or hot weather procedures as necessary.

6. Describe methods to prevent the evaporation rate from exceeding the specification requirements and actions to be taken when ambient and concrete temperatures exceed the requirements of 511.07.

7. Describe the methods of protecting concrete if inclement weather occurs.

8. Describe how and when the vibrator frequency is verified to conform to 511.07.

9. Describe the placement procedures to be used to assure that the tolerances for slipformed concrete meets the requirements of 511.08.

10. Describe the methods and schedule for providing control joints in parapets according to 511.08.

11. Describe the lighting plan equipment and methods, when necessary for placement according to 511.07.

C. Reporting. For the laboratory tested QC air content results report the following information within one day of completing the testing. For the laboratory tested QC compressive strength results report the following information within five (5) days of completing the testing:

1. Sample ID, as provided by the Department *
2. Project number
3. Producer name
4. Class of concrete
5. Batch ticket number
6. Date sampled
7. Lot and sublot identification
8. Placement and sample location
9. Air content
10. Slump
11. Concrete temperature
12. Batch weight *
13. Unit weight *
14. Specimen size *
15. Date tested *
16. Age *
17. Individual strength results and average strength *
18. Type of fracture *
19. Laboratory name
20. Technician name

* Not required when reporting air content test results.

455.04 Additional Quality Control Plan Requirements for Concrete Pavement. In addition to the requirements of 455.02, provide the following information:

A. Division of Pavement into Lots. For the purpose of thickness and strength determination, a lot consists of the entire pavement area of the same pavement thickness and the same class of concrete. Areas using high-early strength concrete are considered a separate lot. In the QCP define the lots for the project. The Engineer will approve the lot division.

B. Division of Lots into Quality Control Sublots. Provide the placement sequence and placement widths for the pavement work and determine the sublot division conforming to Supplement 1064. Provide the Engineer the proposed sublots. The Engineer will approve the sublot division.

C. Material Control Requirements. During production of the concrete pavement, perform the following quality checks:

1. Check the aggregate stockpile conditions, gradation and moisture condition daily.

a. Provide the name and OAIMA Level II certification of the person(s) performing the aggregate gradation.

b. Define the methods of reporting results to the Engineer including whether the concrete aggregate proportions still conform to the mix's well graded requirements.

2. For portable plants, assure that the plant is inspected by the Department prior to placing concrete. Describe the procedures and frequencies to verify the mixer blades condition and the scale, gage, meter and admixture dispenser operation.

3. During paving, perform the following:

a. Air, Slump and Temperature. Sample and test the concrete at least each ½ day of operation at the placement location.

4. Testing for opening the pavement to traffic early according to 451.17. Describe the methods to be used to assure the modulus of rupture obtains 600 psi (4.2 MPa). Define the methods to report results to the Engineer.

D. Pavement Cores for Compressive Strength and Thickness. Define at what age the sublot cores for strength and thickness will be taken. Define the age the cores will be tested for compressive strength. Use cores for thickness determination for compressive strength testing. Determine sublot core locations according to Supplement 1064.

1. Pavement Thickness Measurement. Define who will be measuring the pavement thickness according to Supplement 1064. Define the frequency of reporting pavement thickness results to the Engineer. When the sublot core's thickness is deficient, follow the requirements of 451.18 for additional core locations to determine the deficiency's limits.

2. Define how the Engineer will be provided access to witness the measurements.

3. Define the method and frequency of reporting pavement thickness results to the Engineer

E. Concrete Strength. For each sublot, test the cores for compressive strength using an AASHTO accredited laboratory.

1. Propose the method and frequency of reporting the results to the Engineer for acceptance.

F. Construction Process Requirements

1. Define the minimum required rate of concrete delivery for continuous placement and assure that the equipment and transportation is adequate to provide the concrete at that rate.

2. Describe the methods of protecting the concrete in the case of inclement weather.

3. Describe the methods and frequency of controlling and checking the plastic thickness during paving and reporting issues to the Engineer.

4. Define fine grading methods and equipment

5. Define the procedure and frequency of conditioning the subbase or subgrade before pavement placement.

6. Describe equipment and methods for consistently delivering and evenly spreading the concrete in front of the paver.

7. Describe the procedure for dowel bar or load transfer device installation and methods for determining proper placement location after concrete placement. Assure methods conform with 451.09.B.

8 Describe the type of tie bar or alternate bolt that will be utilized at each longitudinal joint location and methods of placement. Describe the methods and monitoring frequency that will be utilized to assure tie bars are placed and conform with 451.09.A in the finished pavement.

9. Describe methods of monitoring the vibrator operation and frequency, time of day, station location and track speed according to 451.05.B.

10. Describe methods that will be used to ensure that in place concrete conforms to the air entrainment and uniformity requirements after placement and finishing are complete.

11. Define materials, methods and controls for curing and joint sealing and assuring application requirements.

12 Describe joint sawing methods and proposed timing to the sawing operation.

13 Describe finishing and pavement grooving methods.

14. Pavement Smoothness.

a. Define methods to check pavement smoothness conforming to 451.13 and reporting to the Engineer.

b. If other smoothness tolerances are required in the contract define the methods to measure, evaluate, and report the results to the Engineer.

G. Reporting Requirements.

1. Report the following QC testing information to the Engineer daily.

a. Project number

b. Class of concrete

c. JMF number

d. Batch ticket number

e. Date and time sampled

f. Air content

g. Slump

h. Concrete temperature

i. Aggregate moistures results

j. Aggregate gradation results

k. Laboratory name

l. Technician name

2. Report the pavement thickness measurements conforming to the form in Supplement 1064.

3. Report the compressive strength test results from the QC cores sampled according to 451.18.B with the following information:

a. Pavement lot

b. Class of concrete

c. JMF number

d. Sublot number

e. Core location

f. Placement date

g. Age at time of testing, in days

h. Compressive strength.

i. Name of Concrete Producer

j. Name of Contractor

k. Name of laboratory

455.05 Department Quality Assurance. The Department will perform Quality Assurance materials verification sampling and testing as specified or as deemed necessary.

A. Structure Concrete. The Engineer will determine random number locations for QC compressive strength testing of each sublot.

1. Random Number Determination. The Engineer will determine a random number for each sublot to determine from which load the QC sample will be taken using the table in Supplement 1127 or a random number generator.

2. Slump and Air. The Engineer will perform side-by-side air and slump field testing with the Contractor and compare results. If the difference between the Department's and the Contractor's test result is greater than the tolerances listed below, the Contractor and Engineer will determine the reason for slump or air content differences and make necessary adjustments. The Engineer may stop the placement until the reason for the difference is established and corrected. The Engineer will check one of the first three loads delivered. Once the results are within the tolerances listed below, the Engineer may reduce the QA sampling and testing frequency to 10% of the Contractor's subsequent QC tests.

Slump ±1 inch (25 mm)

Air Content ±1%.

3. Compressive Strength. The Engineer will obtain compressive strength QA samples from the same location as the Contractor's quality control samples at a frequency of one QA sample for every 10 sublots, or at least one per lot. The Engineer will make six (6) 4 x 8 inch (100 x 200 mm) cylinders for each sample. The Engineer will mark the cylinders with identification and the Contractor shall provide initial curing at the project.

After the initial curing at the project site and within 72 hours, deliver three (3) QA cylinders to District Testing and three (3) QA cylinders to the AASHTO accredited laboratory for standard curing and testing. Failure to comply with these requirements will be grounds for removal of the AASHTO accredited laboratory from the project at the discretion of the District Testing Engineer and OMM. The AASHTO accredited laboratory will test the QA sample and the QC sample and report the test results on the form accepted by the QCP. Distinguish the QA from the QC results for the sublot.

The Engineer will compare and verify that the tested QC and the matching tested QA test results are within 14% of the Department tested QA result. If the comparison is favorable, the Contractor QC testing is considered verified.

a. When the comparison of the results are more than 14%, investigate the results with the Engineer to determine the reason for the difference. If the reason for the difference cannot be determined to the Engineer's satisfaction, the Engineer will require the Contractor to either non-destructively test or core the concrete represented by the cylinder tests to determine compressive strength. Hire a second independent AASHTO accredited laboratory to perform this additional testing. The Engineer will witness the testing and evaluate the results. The Department will reimburse the Contractor for all testing costs when the Department's results are in

error. If the QC results are found to be valid, use the QC results. If the QC results are not valid, use the core results to determine the compressive strength values for pay factors per 511.22.A.

B. Pavement and Base Concrete. The Engineer will perform side-by-side sampling and testing with the Contractor and compare results.

1. Air Content and slump. The Department will perform quality assurance testing of the air content on at least 10 percent of the Contractor's QC samples. The results will be compared and if the difference between the Department's and the Contractor's test results is greater than ±1% or ±1.0 inch the Contractor and Engineer will determine the reason for difference and make necessary adjustments. The Engineer may stop the placement until the reason for the difference is established and corrected. Make any required modifications or changes to the QCP, the technician, and equipment before continuing paving.

2. Compressive Strength. The Engineer will randomly select 1 out of every 10 QC core locations to have an additional core obtained as a QA strength sample according to Supplement 1127. The QA core sample will be provided to the Engineer and District Testing will cure and test the QA core at the date specified by the Contractor.

The Engineer will compare and verify that the Department tested QA core and the matching Contractor tested QC core test result are within 13% of the District Testing QA result. If the comparison is favorable, the Contractor QC testing is considered verified.

If the difference between core results is greater than 13%, the Engineer will investigate both the Contractor's AASHTO accredited laboratory and District Testing for the accuracy of the equipment and procedures for conducting the compressive strength testing of the cores. If the investigation does not determine the reason for the discrepancy between cores, the Contractor will re-core the sublot in dispute and the core will be tested at OMM. The OMM core result will be compared to the Contractor's QC core result. If the comparison is within 13%, the Contractor's QC result will be accepted and considered verified. If not within the 13% range, the project sublots will be re-cored by the Contractor and tested by the Department. The results will be used for payment under 451.19B.

455.06 QCP Submittal and Corrective Action. Submit the proposed QCP to the Engineer for acceptance at least 10 days prior to placing concrete.

If the submitted QCP is not accepted by the Engineer, revise and resubmit the QCP and provide an additional 10 days for acceptance. Reschedule the concrete placement, when necessary, to allow time for the review and acceptance of the QCP.

The QCP acceptance is based on the concept that the proposed QCP procedures will provide work meeting all specification requirements. If the accepted QCP is not being followed the Engineer will require compliance or re-submittal of any modifications for review and acceptance.

When the actual work produced by the QCP does not conform to specification requirements, the Engineer will require modification of the QCP to return the work to conformance. When notified by the Engineer propose modifications to the QCP

for acceptance. Do not continue work until the Engineer has either accepted the revised QCP or determined work can continue.

455.07 Basis of Payment. The cost of developing and implementing the QCP is incidental to the cost of the concrete sold with the QC/QA requirement.

ITEM 499 CONCRETE—GENERAL

499.01 Description. This specification consists of proportioning requirements for portland cement concrete mix designs, mixing, adjustments and controls, and batch plant requirements for portland cement concrete.

499.02 Materials. Furnish materials conforming to:

Portland cement	701.01, 701.02, 701.04 ..... 701.05, 701.09, 701.15 or blended cement[1]
Micro-silica	701.10
Slag cement	701.11
Fly ash or natural pozzolan	701.13
Fine aggregate [2][3]	703.02
Coarse aggregate[3]	703.02, 703.13[4]
Recycled Concrete Aggregate (RCA)	Supplement 1117
Air-entraining admixture	705.10
Chemical admixture for concrete[5]	705.12
Carbonate micro-fines	705.27

[1] If blended cement is used, provide mill certification of all the cement and pozzolanic components and final product for approval by the Office of Materials Management

[2] 703.02 natural sand or sand manufactured from stone as specified in Item 703.02.A.3 is required in 255, 256, 451, 452, 526, and 511 deck slabs.

[3] Aggregates may be standard gradation sizes from 703.02 and Table 703.01-1 or they may be a modified gradation defined with the mix design submittal and certified by the Office of Materials Management under Supplement 1069.

[4] Applies only to 305, 451 and 452 concrete.

[5] Admixtures shall contain no more than 50 parts per million chloride ions by weight of cement except for Type C accelerating admixtures or calcium chloride for QC-FS only

Use water for concrete mixing free from sewage, oil, acid, strong alkalis, vegetable matter, clay, and loam. Potable water is satisfactory for use in concrete. Non-potable water will meet the requirements of ASTM C1602. Water from a reclaiming system will contain no more than 0.06% chlorides. Test the non-potable water monthly and maintain data verifying that the water meets the requirements. Provide the data at the Engineer's request.

499.03 Concrete Mix Designs. Develop concrete mix designs with 1-inch maximum nominal size coarse aggregate according to ACI 301, Section 4 meeting the requirements of Table 499.03-1. Limit the pozzolan and carbonate micro-fines content of any mix design according to Table 499.03-2 and Table 499.03-3. The design air for concrete with 1-inch nominal maximum size aggregate is 7%. Develop concrete mix designs per this specification and Supplement 1126.

Only use mix designs accepted by the Department and issued a JMF number.

TABLE 499.03-1 CONCRETE MIX DESIGN REQUIREMENTS

Quantities per Cubic Yard (Cubic Meter) Provide Concrete with 7±2% Air Content				
Class	**Design Strength psi (MPa)**	**Permeability [1] Maximum (Coulombs)**	**Cementitious Content [2] Minimum. lbs (kg)**	**Aggregate Requirements**
QC 1	4,000 (28.0) at 28 days	2,000	520 (236)	Well-Graded
QC 1P[9]	4,000 (28.0) at 28 days	2,000	520 (236)	Well-Graded
QC 2	4,500 (31.0) at 28 days	1,500	520 (236)	Well-Graded
QC 3 Special	As per plan	1,500 or as per plan	520 (236) or as per plan	Well-Graded or as per plan
QC 4 Mass Concrete	4,000 (28.0) or as per plan [3]	2,000 or as per plan	470 (213) [4] [5] or as per plan	Well-Graded or as per plan
QC 5 [8]	4500 (31.0) at 28 days	N/A	520 (236)	1 inch or 3/8-inch nominal maximum size
QC SCC [8]	4500 (31.0) at 28 days	1,500 or as per plan	520 (236)	Well-Graded, 1 inch or 3/8-inch nominal size or as per plan
QC MS	See Supplement 1126	N/A	800 (363)	1-inch nominal maximum size
QC FS	See Supplement 1126	N/A	900 (408)	1-inch nominal maximum size
QC Misc. [6]	4,000 (28.0) at 28 days	N/A	550[7] (249)	1-inch nominal maximum size

[1] AASHTO T277 Modified.
[2] Cementitious Content includes cement and pozzolan denoted as Cm.
[3] Strength for Mass Concrete (QC 4) may be tested at either 28 or 56 days.
[4] Do not use Type III cement or accelerating admixtures in mass concrete.
[5] The maximum fly ash, natural pozzolan, or slag cement content may be increased up to 50%.
[6] For QC Misc. mixes only –Water/Cementitious ratio limited to 0.50 maximum.
[7] Cement or a combination of cement and up to 15% fly ash or natural pozzolan; or up to 30% slag cement.
[8] For QC 5 and QC SCC mixes with 3/8-inch nominal size, provide an air content of 8±2%.
[9] Portland cement concrete pavement mix design.

Determine the permeability by testing according to AASHTO T277 except moist cure the permeability samples for 7 days at 73 °F (23 °C) followed by 21 days of moist curing at 100 °F (38 °C). Perform permeability testing at 28 days.

Limit pozzolan materials as a percent of total cementitious content according to Table 499.03-2:

TABLE 499.03-2 POZZOLAN MATERIALS

Materials	Maximum Content (%)
Fly Ash	25
Natural pozzolan	25
Slag Cement	30
Micro-Silica	10
When using multiple pozzolan materials, do not exceed the individual maximum contents above for each material. A combination of pozzolan materials may not exceed 50% of the total cementitious content by weight.	

Limit carbonate micro-fines as a percent of total cementitious content according to Table 499.03-3:

TABLE 499.03-3 CARBONATE MICRO-FINES MATERIALS

Material	Maximum Content (%)
Carbonate Micro-Fines	20
Do not use carbonate micro-fines in Class QC 2 or QC 3 concrete.	

A. Slump and SCC Slump Flow. Maintain slump within the nominal slump range in Table 499.03-4. If below the maximum water-cementitious ratio of the Job Mix Formula (JMF), adjust the quantity of water to meet slump requirements. Water-reducing admixtures conforming to the requirements of 705.12 may also be used or adjusted to meet slump requirements. Do not use concrete with a slump greater than the maximum shown in Table 499.03-4. Conduct tests on the plastic concrete for pavement at the point of placement or at an Engineer-designated location.

TABLE 499.03-4 CONCRETE SLUMP

Type of Work	Nominal Slump inch (mm)[1]	Maximum Slump inch (mm)[2]
Concrete pavement (305, 451, 452, 615)	1 to 3 (25 to 75)	4 (100)
Structural Concrete (511, 610, 622)	1 to 4 (25 to 100)	5 (125)
Superstructure concrete (511, 526)	2 to 4 (50 to 100)	4 (100)
Non-reinforced concrete (601, 602,611, 608, 609, 622)	1 to 4 (25 to 100)	5 (125)
[1] This nominal slump may be increased to 6 inches (150 mm), provided the increase in slump is achieved by adding a chemical admixture conforming to the requirements of 705.12, Type F or G.		
[2] This maximum slump may be increased to 7 inches (180 mm), provided the increase in slump is achieved by adding a chemical admixture conforming to the requirements of 705.12, Type F or G.		

Maintain slump flow within the nominal slump flow range in Table 499.03-5. Do not use concrete with a slump flow greater than the specified maximum for the SCC Class shown in Table 499.03-5. Test for slump flow and Visual

Stability Index (VSI) according to ASTM C 1611. Provide a VSI of zero (0) or one (1) according to the Appendix in ASTM C1611.

TABLE 499.03-5 CONCRETE SLUMP FLOW

SCC Class	Minimum Slump Flow inch (mm)	Nominal Slump Flow inch (mm)	Maximum Slump Flow inch (mm)
Class I	18 (460)	20 (508)	22 (560)
Class II	22 (560)	24 (600)	26 (660)
Class III	26 (660)	28 (710)	30 (760)

B. Air Content. Ensure that the air content in all concrete at the point of placement is within the percentage range specified in Table 499.03-1.

499.04 Adjustments and Controls. Provide the following adjustments and controls during batching and placement of the concrete:

A. Batch the concrete to the proportions of the accepted JMF. Provide a workable and finishable mix. Adjustments to the JMF's aggregate proportions up to 100 lbs (44 kg) for workability may be made. Adjustments greater than 100 lbs (44 kg) may be made if approved by the Engineer. Maintain an absolute volume of 27.0 cubic feet/cubic yard for the adjusted concrete mix. For Well Graded JMF adjustments, maintain the combined aggregate gradation within the optimal zone II requirements for well-graded mixes as defined in Supplement 1126. If outside the optimal zone II of the Coarseness Factor Chart adjust the JMF's proportions to maintain the combined gradation within Zone II and report the JMF changes to the Engineer.

B. Handle, haul and store aggregates to minimize segregation, avoid contamination, and assure a uniform grading within the specified gradation. Do not combine aggregates from different sources or of different gradings in the same stockpile. Do not use segregated or contaminated aggregates.

C. Remove all wash water by reversing each truck drum at the plant immediately prior to reloading.

D. Adjust the SSD aggregate design weights in the JMF to compensate for the moisture contained in the aggregates and moisture the aggregates will absorb during batching. Adjust the mix water to compensate for the aggregate moistures.

E. Use only compatible admixtures in the concrete. Dispense all admixtures according to the manufacturer's recommendations. Furnish a volumetric dispenser for the Type F or G admixture or ensure that there is a gage on each truck-mounted Type F or G admixture dispensing tank. If any admixture is added at the job site, mix the load for a minimum of 5 minutes.

F. Do not exceed the maximum water/cementitious ratio or maximum water/powder ratio of the accepted JMF. Use a water-reducing admixture conforming to 705.12; proportionately increase the cementitious content; or develop and submit for acceptance a new JMF. Adjust the absolute volume of the aggregates if the cementitious content is increased.

G. If during placement of concrete, cement or micro-silica balling is observed, take corrective action with further mixing. If after corrective action, balling

continues, reject the load. Revise the mixing process and/or loading sequence to prevent further balling.

H. If slump loss occurs before or during placement of the concrete, the concrete slump may be field adjusted to restore plasticity with a Type F or G chemical admixture conforming to 705.12, additional water, or both, only if the maximum water-cementitious ratio of the accepted JMF is not exceeded. Mix for a minimum of 30 revolutions at mixing speed after addition of admixture, water, or both. Inform the Inspector, record all adjustments, and confirm compliance with 499.03A. The Engineer will recheck the slump and air content to ensure conformance to the specification. If after any adjustment the components of the load are segregated, the Department will reject the load.

I. Completely discharge the concrete from each delivery truck within the time requirements of 499.08.

J. Provide sufficient quality control at the plant to assure conformance with this specification and project requirements.

K. Use an approved set-retarding admixture conforming to 705.12, Type B or D when the concrete temperature exceeds a nominal temperature of 75 °F (24 °C).

499.05 Equipment. Use a Department approved batch plant and trucks. Provide batching and mixing equipment meeting the following requirements:

A. Batching Plants. Operate each plant so that aggregate materials are not segregated and there is no intermingling of the materials before batching. Use weighing mechanisms that allow a visible means of checking weights and produce a printed record. Use dispensing mechanisms for water and admixtures that allow a visible means of checking quantities and produce a printed record.

Use cement and aggregate weighing mechanisms that are accurate to within ±0.5 percent of the correct weight. Ensure that devices for weighing or metering water are accurate to ±1.0 percent throughout the range used.

Maintain a certification from a Sealer of Weights and Measures or a scale servicing company attesting to the accuracy of the weighing and metering devices. A Certificate of Performance issued by the National Ready Mixed Concrete Association may be used instead of the Sealer of Weights and Measures or a scale servicing company. Do not use plants with a certification or certificate older than 12 months

Maintain the services of a scale servicing company or ten standard test weights to reach a capacity of 500 pounds (227 kg) for testing the weighing devices at the batch plant. Ensure all device-testing weights are sealed by the Ohio Department of Agriculture every 3 years.

The Engineer may test weighing and dispensing devices as often as necessary to ensure continued accuracy.

B. Mixers. Provide mixers and agitators conforming to AASHTO M 157, Sections 10, 11.2, 11.5, and 11.6, except that the Department will allow mechanical counters.

For bodies of non-agitating concrete hauling equipment, provide smooth, mortar-tight, metal containers capable of discharging the concrete at a satisfactory controlled rate without segregation. Provide covers when required by the Engineer. The Engineer will allow trucks having dump bodies with rounded corners and no internal ribs or projections for non-agitating hauling.

C. Concrete Pumping and Conveying Equipment. Provide concrete pumping and conveying equipment in accordance with ACI 304.2R and ACI 304.4R. Conduct a pre-placement meeting to discuss concrete pumping and conveying procedures to maintain air content within specified limits per Table 499.03-1.

D. Volumetric Truck Mixers. Volumetric Truck Mixers. Provide mixers conforming to ASTM C685, Sections 7, 8, 9, 10, 11, 13, and 14. Mixers must have rating plates indicating that the performance of the mixer is in accordance with the Volumetric Mixer Manufacturer Bureau or equivalent. Mix concrete in accordance with the manufacturer's recommended procedures. The volumetric mixer must be capable of carrying sufficient unmixed dry bulk cement, supplementary cementitious materials, coarse and fine aggregate, admixtures and water, in separate compartments and accurately proportion the approved JMF. Each volumetric mixer shall be equipped with an onboard ticketing system that will electronically produce a record of all material used and their respective weights and the total volume of concrete placed. Place no more than 30 cubic yards (23 m^3) per unit per day. Limit the use of volumetric truck mixers to QC Misc., QC MS, QC FS, and Item 613.

Provide a process control plan, product quality control plan, and manufacturer's recommended procedures to the OMM Cement and Concrete Engineer. Calibrate the proportioning devices before the start of a project and at intervals recommended by the manufacturer. Perform calibrations in the presence of the Engineer. Calibrate the cement and aggregate proportioning devices by weighing (determining the mass of) each component. Calibrate the admixture and water proportioning device(s) by weight (mass) or volume. Batch each material to ensure weights are within the tolerances listed in Table 499.06-2, based on the amount specified in the accepted JMF. Furnish batch tickets in accordance with Item 499.07. Verify yield daily based on the cement meter count (number of revolutions per 94 pounds (42.5 kg) of cement), for each volumetric truck mixer.

499.06 Handling, Measuring, and Batching Materials. Do not stockpile aggregates from different sources or different gradations together. Do not use aggregates that have become segregated or mixed with foreign material. The Engineer may direct reworking or cleaning, or may reject aggregates that have become segregated or mixed with earth or foreign material.

Prior to and during batching, maintain all coarse aggregates at a uniform moisture content.

For all slag aggregates or other aggregates with a reported absorption above 3.0 percent, maintain the moisture contents at or above the ODOT-reported SSD for that aggregate as follows:

A. Use appropriate stockpile watering systems capable of raising and maintaining aggregate moisture at or above SSD. Test the moisture content of the watered

aggregate stockpiles at least five (5) locations to assure the stockpile is at or above SSD.

B. Have processes to maintain the aggregate stockpile at SSD until stockpile draining for SSD consistency has begun. Twenty-four (24) hours before batching concrete with the aggregate, shut down the stockpile watering process to allow drainage and to establish a uniform moisture content.

C. Test aggregate moisture content at least once per half day, but not less than twice per day, during concrete production. If the moisture content varies between tests by more than 1 percent increase the moisture testing frequency to assure correct batching information.

D. Provide the moisture content test results as part of all quality control plant ticket information.

Separately weigh the amounts of fine aggregate and coarse aggregate. Use a separate weighing device for cementitious materials.

Batch each material to ensure weights are within the tolerance specified in Table 499.06-1, based on the amount specified in the approved JMF.

TABLE 499.06-1 CONCRETE BATCHING TOLERANCES

Material	Batching Tolerance (%)
Cement	±1.0
Pozzolan[1]	±1.0
Carbonate Micro-fines[2]	±2.0
Aggregates[2]	±2.0
Water[3]	±1.0
Chemical Admixtures	±3.0
[1] Tolerance is on cumulative target weight when weighing together with cement [2] Tolerance is on cumulative target weight when weighing together with more than one aggregate [3] Measured by weight or volume	

TABLE 499.06-2 VOLUMETRIC TRUCK BATCHING TOLERANCES

Material	Batching Tolerance (%)
Cement	0.0 to +4.0
Pozzolan	0.0 to +4.0
Carbonate Micro-fines	0.0 to +4.0
Aggregates	±2.0
Water	±1.0
Chemical Admixtures	±3.0

499.07 Batch Plant Tickets. Furnish a concrete batch plant ticket to the Engineer for each load of concrete incorporated into the project. Provide computer generated batch tickets. At a minimum, include the information listed in Table 499.07-1 on each ticket:

TABLE 499.07-1 EVERY BATCH TICKET

Name of ready-mix batch plant	
Batch plant No.	
Batch plant location	
Producer/Supplier Code	
Serial number of ticket	
Date	
Truck number	
Class of concrete	
JMF Number	
Batch time	
Batch size	yd^3 (m^3)
Actual weights and batch tolerance of cementitious material:	
Cement	lb (kg)
Fly ash	lb (kg)
Natural pozzolan	lb (kg)
Slag cement	lb (kg)
Micro-silica	lb (kg)
Other	lb (kg)
Actual weights and batch tolerance of aggregates:	
Coarse	lb (kg)
Intermediate	lb (kg)
Fine	lb (kg)
Carbonate Micro-Fines	lb (kg)
Other	lb (kg)
Actual weight of water and batch tolerance	lb (kg)
Actual volume of admixtures:	
Air-entrainer	fl oz (mL)
Superplasticizer	fl oz (mL)
Water-reducer	fl oz (mL)
Retarder	fl oz (mL)
Other	fl oz (mL)
Aggregate moisture contents:	
Coarse aggregate	%
Intermediate aggregate	%
Fine aggregate	%
Water-cementitious ratio, leaving the plant	

Provide the information in Table 499.07-2 with batch tickets for each day's first load of concrete and for each JMF. Include Table 499.07-2 information on the batch ticket or furnish the information on a separate computer-generated or handwritten

form attached to the batch ticket. Provide moisture adjustment calculations for all coarse and fine aggregate according to 499.06.C.

If during the concrete manufacturing process any of the information listed in Table 499.07-2 changes, resubmit Table 499.07-2 information with the first batch ticket supplied with the changed concrete.

TABLE 499.07-2 FIRST TICKET EACH DAY, EACH JMF

Cementitious Materials:	Source:	Grade or Type:
Cement		
Fly ash		
Natural pozzolan		
Slag cement		
Micro-silica		
Other		
Admixtures	Brand:	Type:
Air-entrainer		
Retarder		
Superplasticizer		
Water-reducer		
Other		

The provided concrete batch ticket information is according to ASTM C 94/C 94M, Section 14.

The Engineer may require supporting data to validate the basis for furnished aggregate moisture contents.

499.08 Mixing Concrete. Use a central mix plant or in truck mixers to mix the concrete.

When using a central mix plant, mix the concrete not less than 60 seconds Begin the mixing time when all materials are in the drum and end the mixing time when discharge begins. Include transfer time in multiple drum mixers in the mixing time. Remove the contents of an individual mixer drum before a succeeding batch is emptied into the drum.

When concrete is mixed using a truck mixer for complete mixing, mix each batch of concrete at the rotation rate designated on the mixer as mixing speed for not less than 70 revolutions of the drum. Transport mixed concrete from the central mixers in truck mixers, truck agitators, or trucks having non-agitating bodies. Within 90 minutes after cement and water are combined, deliver and completely discharge concrete.

Use admixtures containing no more than 50 parts per million chloride by weight of cement only when specified in the Contract Documents, the accepted JMF, or with the Engineer's written permission.

Ensure that the temperature of all concrete does not exceed 95 °F (35 °C) until incorporated into the work.

500 STRUCTURES

ITEM 501 STRUCTURES—GENERAL

501.01 General. This specification includes the general requirements for building the various items that constitute the completed structure.

Perform the work, including fabrication, erection, and construction, so that the entire structure and all its component parts will function as designed.

501.02 Verification of Dimensions. Verify that all dimensions established by the Engineer are correct.

501.03 Notification of Fabricator. When furnishing materials under Items 513, 515, 516, 517, and 518, select a fabricator from the pre-qualified fabricators list in effect the date of the Contract letting. Before or at the preconstruction conference, provide a written notification to the DCE, DET and OMM of the selected steel fabricators and precast concrete fabricators. Payment per 109.10 will not be made until 30 days after OMM is notified and proper documentation is receive

501.04 Shop Drawings. Provide shop drawings detailing structural steel, metal structural elements, prestressed concrete members, precast concrete structural elements, and other similar materials requiring either shop or field fabrication. Include the PID (Project Identification Number).

A. Contractor Acceptance of Shop Drawings for Items 513 and 515. Submit shop drawings to the OMM and the District Office of Planning and Engineering before the start of fabrication on Item 513, UF Level or at least 3 days before the pre-fabrication meeting, per 513.07 or 515.07 as follows:

For structures carrying railroad traffic, submit four copies of the prepared shop drawings at least 40 days prior to the pre-fabrication meeting to each railroad company involved for review and approval. Resolve all railroad comments prior to submitting drawings to OMM. The submission to OMM shall include one set of shop drawings accepted by each railroad company involved; copies of all documentation between the railroad(s) and the Contractor; four sets of Contractor accepted shop drawings, and the Contractor's written acceptance letter. Also furnish the fabricator's quality control specialist with one additional set of these drawings before the pre-fabrication meeting.

For all other structures, the submission to OMM shall include a written acceptance letter and four copies of each drawing, unless additional copies are

requested. Also, furnish the fabricator's quality control specialist with one additional set of these drawings before the pre-fabrication meeting.

Have competent individuals prepare and check the shop drawings. The preparer(s) and checker(s) shall initial each sheet and shall be different individuals. Provide, on the cover sheet or submittal letter, the first name, last name and initials of each preparer and checker performing work on the shop drawings. Have an Ohio Registered Engineer sign, seal and date the shop drawing cover sheet or submittal letter according to ORC 4733 and OAC 4733-35 confirming that the shop drawings meet the intent of the contract. If multiple preparers or multiple checkers created the drawing, then the cover sheet or submittal letter shall clearly indicate the portions for which each person is responsible. Have all questions and comments addressed before submitting the shop drawings.

The Contractor's written acceptance letter shall document acceptance of the shop drawings including confirmation of field verification, as required, and descriptions of issues resolved between the Contractor, the fabricator, or the Department.

By accepting these shop drawings, the Contractor represents to the Department that all dimensions and elevations of existing conditions shown on the plans have been field measured and verified, and that these shop drawings comply with all the materials requirements, construction requirements, contract requirements, and performance criteria. The Contractor further represents that these drawings have been coordinated and verified with the details of the work to be performed by other fabricators and entities on the project. The Department will not make any allowance for additional cost or delays to the Contractor for incorrect fabrication as a result of failure to coordinate or perform this acceptance.

If the Department requests changes on these shop drawings, or the Contractor makes changes in addition to those expressly requested, revise the shop drawings and submit a new cover sheet, signed, sealed and dated by an Ohio Registered Engineer with suitable revision marks to identify the changes.

Schedule the pre-fabrication meeting after OMM receives the drawings. Fabrication may begin after the pre-fabrication meeting is complete or after receipt of Item 513, UF Level drawings.

B. Fabricator Coordination of Shop Drawings for Items 516, 517, and 518. The Contractor and fabricator must coordinate these shop drawings. Ensure that shop drawings meet requirements for materials, field measurements, construction requirements, contract requirements, performance criteria, and similar data. The coordination must also include details of the work to be performed by other fabricators and entities on the project. The Department will not make allowance for additional cost or delays to the Contractor for incorrect fabrication as a result of failure to coordinate or perform this coordination. Shop Drawings are not required for elastomeric bearings.

Submit two copies of the shop drawings to the Engineer and one copy to the District Office of Planning and Engineering with the materials delivered to the project. Do not incorporate material into the work until after submitting the drawings. Department approval of these shop drawings is not required.

C. Shop Drawing General Requirements. Specific requirements are specified in Item 513, 515, 516, 517, or 518.

Shop drawings shall be neatly and accurately drawn on 11 x 17 inch or 22 x 34-inch (280 x 432 mm or 559 x 864 mm) sheets. Submit the shop drawings electronically in pdf format.

501.05 Submittal of Engineered Drawings. Design and perform all procedures as directed by the *AASHTO Standard Specifications for Highway Bridges* or the *AASHTO LRFD Bridge Design Specifications* except as modified below:

Perform daily inspections to ensure the work governed by the Engineered Drawing is functioning as designed. Report malfunctioning work to the Engineer immediately.

A. Projects with Railroad Involvement. Prepare and provide Engineered Drawings listed in this section as follows:

Have competent individuals prepare, check and initial each Engineered Drawing. The preparer and checker shall be different individuals. Provide, on the cover sheet or submittal letter, the first name, last name and initials of each preparer and checker performing work on the Engineered Drawings. Have an Ohio Registered Engineer sign, seal, and date the cover sheet or submittal letter according to ORC 4733 and OAC 4733-35. If multiple preparers or multiple checkers created the drawing, then the cover sheet or submittal letter shall clearly indicate the portions for which each person is responsible.

Submit Engineered Drawings to all involved railway companies at least 50 days before planned construction begins. Do not include calculations unless requested by the railroad or the Engineer. Obtain acceptance from all involved railroad companies. Furnish the Engineer copies of all correspondence with the railroad, documentation of railroad acceptance and the Engineered Drawings accepted by the railroad.

After all involved railroad companies have accepted the Engineered Drawings, schedule an Engineered Drawing meeting to be held within 14 days of the work. The signatory Engineer responsible for the Engineered Drawing design, the Quality Control Representative (QCR) (if designated), the Superintendent, the Engineer and the Inspector will participate in the meeting in person, via conference call or via video conference. The superintendent or other on-site personnel and the QCR may be the same person. The Engineer will invite the responsible designer of the Plans for assistance and the Railroad Field Representative. The purpose of the meeting shall be to review the drawings; resolve all issues to the Engineer's satisfaction and ensure all parties are in agreement with the work to commence. At the conclusion of the meeting, the Engineer will provide a written response to the submittal in accordance with C&MS 105.02. Do not begin work until the Engineer's acceptance has been received.

Perform all work in accordance with the ODOT accepted Engineered Drawings. The Signatory Engineer shall be available during the work to confirm that all work and equipment is in accordance with the Engineered Drawings. Alternatively, the Signatory Engineer may designate an on-site Quality Control Representative with the authority to confirm all the work and equipment as

authorized is in accordance with the Engineered Drawings. The limits of the QCR's authority will be determined by the Signatory Engineer and put into writing prior to proceeding with associated work.

The Signatory Engineer or the QCR shall respond in writing to all clarifications of plan conformance requested by the Engineer or Inspector during the progress of the work. The Department will consider a failure to respond to a clarification request as a deviation to the accepted Engineered Drawings.

Immediately cease all operations that deviate from the ODOT accepted Engineered Drawings. If a deviation is necessary, prepare revised Engineered Drawings as noted above and furnish the Engineer a copy of revised Engineered Drawings including documentation of acceptance from all involved railroad companies. Schedule an Engineered Drawing meeting as noted above to be held 24 hours, or less at the discretion of the Engineer, after submitting the revised railroad accepted drawings. At the conclusion of the meeting, the Engineer will provide a written response to the submittal in accordance with C&MS 105.02. Do not begin work until the Engineer's acceptance has been received.

The Department will consider delays resulting from Engineered Drawing deviations as non-excusable in accordance with 108.06.E.

This section applies to Engineered Drawings for the following:

1. Bracing adjacent to the railroad tracks. Perform work according to 501.05.B.1.

2. Demolition of structures over or within 14 feet of railroad tracks. Perform work according to 501.05.B.2.

3. Erection of structural members over or within 14 feet of railroad tracks. Perform work according to 501.05.B.4.

B. Projects without Railroad Involvement. Prepare and provide Engineered Drawings listed in this section as follows:

Have competent individuals prepare, check and initial each Engineered Drawing. The preparer and checker shall be different individuals. Provide, on the cover sheet or submittal letter, the first name, last name and initials of each preparer and checker performing work on the Engineered Drawings. Have an Ohio Registered Engineer prepare, sign, seal and date the cover sheet or submittal letter according to ORC 4733 and OAC 4733-35. If multiple preparers or multiple checkers created the drawing, then the cover sheet or submittal letter shall clearly indicate the portions for which each person is responsible.

Schedule an Engineered Drawing meeting to be held within 14 days of the work. Submit Engineered Drawings to the Engineer at least 7 days prior to the meeting. Do not include calculations unless requested by the Engineer. The signatory Engineer responsible for the design, QCR if designated), the Superintendent, the Engineer and the Inspector will participate in the meeting in person, via conference call or via video conference. The superintendent or other on-site personnel and the QCR may be the same person. The Engineer will invite the designer of the contract Plans for assistance. The purpose of the meeting shall be to review the drawings; resolve all issues to the Engineer's satisfaction and ensure all

parties are in agreement with the work to commence. At the conclusion of the meeting, the Engineer will provide a written response to the submittal in accordance with C&MS 105.02. Do not begin work until the Engineer's acceptance has been received.

Perform all work in accordance with the accepted Engineered Drawings. The Signatory Engineer shall be available during the work to confirm that all work and equipment is in accordance with the Engineered Drawings. Alternatively, the Signatory Engineer may designate an on-site QCR with the authority to confirm the work and equipment as authorized is in accordance with the Engineered Drawings. The limits of the QCR's authority will be determined by the Signatory Engineer and put into writing prior to proceeding with associated work.

The Signatory Engineer or the QCR shall respond in writing to all clarifications of plan conformance requested by the Engineer or Inspector during the progress of the work. The Department will consider a failure to respond to a clarification request as a deviation to the accepted Engineered Drawings.

Immediately cease all operations that deviate from the accepted Engineered Drawings. If a deviation is necessary, prepare revised Engineered Drawings as noted above and furnish the Engineer a copy of revised Engineered Drawings. Schedule an Engineered Drawing meeting as noted above to be held 24 hours, or less at the discretion of the Engineer, after submitting the revised drawings. At the conclusion of the meeting, the Engineer will provide a written response to the submittal in accordance with C&MS 105.02. Do not begin work until the Engineer's acceptance has been received.

The Department will consider delays resulting from Engineered Drawings deviations as non-excusable in accordance with 108.06.E.

This section applies to Engineered Drawings for the following:

1. Cofferdams and Excavation Bracing. If a complete design is not provided in the plans, provide Engineered Drawings for excavations when the edge line of a roadway used to maintain traffic is located within a distance of one-half times the excavation height or for excavations that expose any side of an excavation to a height exceeding eight feet.

The Contractor may construct the design(s) shown on the plans without an Engineered Drawing submittal or prepare an alternate design. Submit Engineered Drawings for all alternate Cofferdam and Excavation Bracing designs. Perform all Work as specified below:

a. Locate Cofferdams and Excavation Bracing according to the contract, if shown.

b. Maintain temporary horizontal and vertical clearances according to the contract.

c. Include the effects of AASHTO live, dead and temporary construction load surcharges as necessary.

d. Design Cofferdams and Excavation Bracing to support the sides and bottom of an excavation for all phases of work in accordance with the latest

edition of the ODOT Bridge Design Manual and either the latest AASHTO Guide Design Specifications for Bridge Temporary Works, Section 4 or the latest edition of the AASHTO LRFD Bridge Design Specifications.

2. Demolition of Bridges or portions of Bridges in which the work endangers property or the welfare, life, or health of any individual. Perform all Work as specified below:

a. Provide temporary devices or structures necessary to protect traffic during all demolition activities. Provide traffic protection when demolition is located less than 12' horizontally from active traffic on structures of less than 25' vertical clearance. Increase the 12' minimum horizontal distance 1 foot for each 2 feet of additional height greater than 25'.

b. Never lift the portions of structure being removed over active traffic. Before releasing traffic make the remaining structure stable.

c. Design traffic protection devices or structures when over live traffic, for a minimum load of 50 pounds per square foot plus the weight of equipment, debris and any other load to be carried. Include any portion of the deck that cantilevers beyond the fascia beams or girders.

d. In lieu of temporary devices or structures required in “a.” above, provide a vertical barrier. Design the vertical barrier with rigid or flexible materials specifically designed for demolition containment. Extend the enclosure up to the bottom of the deck and down to the ground. Maintain all materials free of tears, cuts and holes.

e. Maintain temporary horizontal and vertical clearances according to the contract.

f. Locate structural members to be reused before performing any removal operations.

g. Do not damage structural members being reused during any removal operation.

h. Perform Work so that all members are stable during all operation and loading conditions.

i. Provide the method and sequence of the removal operations. Include the type and location of equipment to be used during the demolition.

j. Perform Work according to 501.05.B.6.

3. Falsework for cast-in-place concrete slab bridges. Perform all work according to 508 and as specified below:

a. Provide a camber table to account for the deflection of the falsework loaded with its self weight and the weight of wet concrete. Also include in the table, the specified camber to compensate for slab deflection after the falsework is released.

b. Maintain temporary horizontal and vertical clearances according to the contract.

c. As a minimum design falsework over waterways for a five year flood or with 75 percent of the effective waterway opening of the proposed structure. The Contractor is responsible for any damages caused by upstream flooding due to insufficient temporary structure size or the accumulation of debris or sediment in the channel.

d. Support falsework foundations located within the ten year flood limits on rock, shale or piles driven to a minimum depth of 15 feet, and to sufficient penetration to carry superimposed loads or until refusal on rock.

e. The incorporation of structural steel shapes, used as temporary support members, into a finished concrete slab superstructure is prohibited.

f. Design falsework in accordance with the latest AASHTO Guide Design Specifications for Bridge Temporary Works, Section 2.

4. Erection of steel or precast concrete structural members as specified below:

a. Never lift structural members over active traffic. Before releasing traffic make structural members stable

b. Supply any temporary supports or braces necessary to maintain structural stability and prevent lateral movement until completion of all construction activities.

c. Perform Work according to 501.05.B.6, 513 or 515.

d. Do not field weld temporary members to permanent steel members.

e. Maintain temporary horizontal and vertical clearances according to the contract.

f. Provide drawings with at least the following information:

(1) Site Plan of the work area showing permanent support structures (piers and abutments); roads; railroad tracks; waterways; overhead and underground utilities; and other information pertinent to erection.

(2) Erection sequence for all members, noting any temporary support conditions, such as holding crane positions, temporary supports, falsework etc. Member reference marks, when reflected on the erection plans, should be the same used on the shop drawings.

(3) Primary member delivery location and orientation.

(4) Maintenance of Traffic during erection operations.

(5) Location of each crane for each primary member pick, showing radius and crane support (barges, mats, etc.).

(6) Capacity chart, Counter Weights, Make and Model for each possible lifting equipment configuration and boom length used in the work.

(7) Center of gravity locations for primary member.

(8) Rigging weights, capacity and arrangement for primary member picks.

(9) Lifting weight of primary member picks, including all rigging and pre-attached elements.

(10) Details of any temporary lifting devices to be bolted or welded to permanent members, including method and time (shop or field) of attachment; capacity; and method, time, and responsibility for removal.

(11) Blocking details for bridge bearings.

(12) 24 Hour Contact Phone Number of the Signatory Engineer and QCR (if designated).

5. Jacking and support of existing structures as specified below:

a. Support the structure on temporary supports and brace as necessary to maintain structural stability and prevent lateral movement until completion of the permanent supports. Do not rely on jacks lifting system alone,(e.g. hydraulic system), to support the structure except during the actual jacking operation. Remove all temporary supports upon completion of the jacking procedure.

b. Maintain a maximum differential jacking height of 1/4 inch between any adjacent beam lines.

c. Maintain a maximum differential jacking height of 1 inch between any adjacent abutments or piers.

d. Place jacks and any load plates at least 2 inches from the edges of any concrete substructure seats.

e. Do not field weld temporary members to permanent steel members.

f. Maintain temporary horizontal and vertical clearances according to the contract.

6. When the total load applied to a structure during construction, (new or structure being rehabilitated), exceeds 75 percent of the legal limit, (The Legal Limit is 80,000 lbs. or percentage thereof if posted), the load effects on the structure shall be analyzed based on the operating level calculated by the Load Factor Rating Method as given in the AASHTO Manual for Bridge Evaluation.

7. Structures for maintaining traffic in accordance with Item 502.

a. For structures located over or within 14 feet of railroad tracks, submit plans in accordance with 501.05.A.

b. Perform Work according to 501.05.B.6.

C. Corrective Work. Unless otherwise noted, before performing corrective work on structure items, 507,511,513,515,516,517 and 524, prepare a Corrective Work Plan (CWP). Submit three copies of the CWP to the Engineer for acceptance 30 days, or less at the discretion of the Engineer before construction begins. Have an Ohio Registered Engineer prepare, sign, seal and date each CWP. Obtain Department acceptance before beginning corrective work

Perform all Work in accordance with the accepted CWP. Immediately cease all operations that deviated from the accepted CWP. If a deviation is necessary, furnish the Engineer three copies of a revised CWP. The revised CWP shall be

signed, sealed and dated by an Ohio Registered Engineer. Obtain Department acceptance of revised CWP prior to performing corrective work.

Perform all corrective work, including the preparation of the CWP and revisions at no expense to the Department. The Contractor shall reimburse the Department for all CWP review costs of the Designer of Record. The Department will consider delays resulting from all corrective work as non-excusable in accordance with 108.06E.

501.06 Test Reports

A. Contractor Acceptance of Materials for Item 513. Submit certified test data to the Director showing compliance with the requirements of Item 711. Accompany all certified test data with copies of mill shipping notices or invoices showing the quantity and size of material being accepted. Mill certifications for Fracture Critical Materials shall include FCM statement.

Check this material data and provide a letter of written acceptance. Submit the material data and letter of written acceptance to the Director so that the Director receives them at least 7 days before final shop inspection Item 513, Levels 1 through 6 or before final shop inspection Item 513, UF Level.

Submit a single copy of this material data for each structure, except where the structure carries railway traffic. Submit one additional copy to each railway company involved.

Additionally for Item 513, Levels 1 through 6 structural steel members, submit one copy of main material, certified test data with a letter documenting the QCFS acceptance to the QA shop inspector before the material passes check point one.

The Department will not accept materials for final inspection at the fabrication shop until the Director receives the Contractor accepted material data.

B. Fabricator Certification of Materials for Items 516, 517, and 518. Ensure that a letter of certification accompanies the fabricated material shipped to the job site, in a format approved by the Director, stating all materials conform to contract requirements. For these materials, the fabricator must retain certified test data, copies of mill shipping notices, or invoices showing the quantity and size of material being accepted. This data shall provide complete traceability to the producing mill and proof of domestic origin, as required by ORC 153.011.

Do not deliver materials to the project without the certification letter.

501.07 Welded Attachments. Prepare and provide a detailed request showing weld size, length, type and location for welding permanent or temporary attachments to main structural members not shown or permitted by contract. Submit request to the Office of Structural Engineering at least 20 days before construction begins. Obtain acceptance before performing work. Perform work according to 513.

ITEM 502 STRUCTURES FOR MAINTAINING TRAFFIC

502.01 Description. This work consists of preparing plans, providing, maintaining, and subsequently removing temporary structures.

502.02 Design and Construction. As a minimum, design the temporary structure for a 5-year flood or with 75 percent of the effective waterway opening of the proposed structure. The Contractor is responsible for any damages caused by upstream flooding due to insufficient temporary structure size or the accumulation of debris or sediment in the channel. Provide a clear roadway width of at least 23 feet (7.0 m) measured from face to face of guardrails. If the existing structure or approaches or both have sidewalks provide at least one sidewalk at least 5 feet (1.2 m) wide with adequate connections to existing walks and in compliance with accessibility standards.

Design the temporary structure according to the AASHTO LRFD Bridge Design Specifications except that the design live loading, HL-93 may be reduced by 25 percent.

Submit working drawings in accordance with 501.05.

Drive piling to sufficient penetration to carry the superimposed loads according to Item 507, but not less than 24 tons (24 metric tons) per pile. Perform dynamic load testing to determine required blow count if piles are not driven to rock.

If the plans state that the existing superstructure may be used instead of new construction, do not alter it to meet either the above width or strength requirements. Instead, move or dismantle and re-erect with sufficient care to avoid any reduction of capacity. If the superstructure has been restricted by posting to loads less than permitted by statute, move the posting signs to the temporary road, unless the superstructure is strengthened to a legal load capacity. If planning to use the existing superstructure on the temporary road, notify the Engineer at least 3 days before the superstructure is moved to allow the Department to establish a detour. Complete the bridge within 48 hours after traffic has been routed over the detour.

502.03 Maintenance. Maintain all portions of the temporary structure in good condition with respect to both safety and smoothness for travel as long as it is needed for maintenance of traffic. Satisfactorily maintain the channel and waterway opening.

502.04 Removal. If the temporary structure is no longer needed, take ownership and remove it from the site according to Item 202.

502.05 Basis of Payment. Payment is full compensation for erection, maintenance, performing dynamic load testing, and subsequent removal of temporary structures.

The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
502	Lump Sum	Structure for Maintaining Traffic

ITEM 503 EXCAVATION FOR STRUCTURES

503.01 Description. This work consists of designing cofferdams and excavation bracing, and excavating materials not removed under other items of work that must be removed to enable construction of bridges, and other structures. Included in this work are:

A. constructing, maintaining, and subsequently removing cofferdams and excavation bracing;

B. dewatering and backfilling the excavation;

C. protecting the excavation against collapse; and

D. disposing of materials not required or suitable for backfill.

503.02 Classification. Excavation is classified as unclassified excavation, unclassified excavation including rock (or shale), or rock (or shale) excavation.

503.03 Cofferdams and Excavation Bracing. This item includes the preparation of an Engineered Drawing according to 501.05, and the construction, maintenance, and subsequent removal of all cofferdams and excavation bracing. A cofferdam is an enclosure within a water environment constructed to allow dewatering for the purpose of creating a dry work environment. Excavation bracing is that required to safely support the sides of excavations, embankments, adjacent buildings, tracks, or other premises.

Construct cofferdams and excavation bracing such that support members clear the top of the footings by at least 1 foot (0.3 m). If this is not practical, support members shall be structural steel and left it in place. If bracing is to be left in place and the ends would not be visible when the structure is completed, burn off the steel ends flush with the concrete surface. If ends would be visible, form a 6 inch (150 mm) deep recess around the steel embedment and remove the external portion of the embedment to provide at least 3 inches (75 mm) of clearance to the finished concrete face. Completely fill the resulting recess with concrete.

Where water is not encountered, the Contractor may place excavation bracing at the plan dimension of the footing and use it as formwork for footing concrete. Leave this sheeting in place at least to the top of the footing, or properly separate it from the footing concrete so that it may be removed without damaging the concrete.

Where water is encountered, and cofferdams are necessary, construct them practically watertight before excavating below water level. Make provisions outside the footing to drain, collect, and remove water. When placing concrete, keep the excavation dewatered until the concrete is above the prevailing water level. Effectively protect footing concrete from erosion. If using a concrete seal to stop the flow upward from the bottom of a cofferdam, place the seal below the planned footing and consider it as a part of the cofferdam. The Department will not pay for a seal unless it is shown on the plans.

Unless otherwise shown in the plans, design and construct cofferdams to accommodate a water elevation 3 feet (1.0 m) above the ordinary high water mark shown on the plans. If the actual water elevation exceeds 3 feet (1.0 m) above the stated ordinary high water mark, the Department will reimburse the Contractor for any resulting damage to the work protected by the cofferdam provided the Contractor has exercised normal due diligence. If the actual water elevation exceeds 3 feet (1.0 m) above the ordinary high water mark and causes a delay to the project, the Department will grant the Contractor an excusable, non-compensable delay in accordance with 108.06.B.

Establish a monument upstream of all proposed cofferdams to visually monitor the water elevation in the waterway. Maintain the monument throughout the project. Provide a visual mark on the monument that identifies the required high water elevation as defined above. Ensure that the monument can be read from the bank of the waterway. Have this elevation set and certified by an Ohio Registered Surveyor.

Cofferdams may be designed and constructed to accommodate a lower water elevation; however, the Department will not reimburse the Contractor for repairs to work damaged nor grant additional time unless the water elevation exceeds 3 feet (1.0 m) above the ordinary high water mark shown on the plan.

Submit any request for reimbursement for repair to work damaged or for delay to the Engineer with information substantiating that the water elevation was more than 3 feet (1.0 m) above the ordinary high water mark shown on the plans.

503.04 Protection for Excavation. Protect all excavations from caving. Do not disturb the material below the bottom of footings. Perform blasting in a manner that avoids damage to the material supporting the structure vertically or laterally and that avoids subsequent slides that damage the structure, road, or adjacent property. If the material below the bottom of footings not supported by piles is disturbed, remove it and fill the entire space with concrete at no expense to the Department. Under footings supported on piles, replace and compact the over-excavated or disturbed material as the Engineer directs. If backfilling is necessary to correct caving or slides, backfill according to 503.08.

Excavation adjacent to railroad tracks are subject to the supervision of the involved railway company. Provide sufficient bracing to ensure the proper support of the roadbed and tracks.

503.05 Footings in Rock. Where rock or shale excavation is a separate pay item, fill the portion of the excavation into rock or shale that is below the top of footing with concrete.

If removing rock or shale as part of Unclassified Excavation and the footing is designed to be keyed into the bedrock, confine the excavation into bedrock for the minimum specified depth of keying within the area bounded by the outer edge of the footing. Fill excavation outside these limits and within and below the keyed depth with concrete.

503.06 Approval of Foundations. Notify the Engineer when the excavation is to be completed to the depth shown on the plans. Do not place footings until the Engineer has approved the subfoundation.

503.07 Disposal of Excavated Material. Dispose of excavated material not needed or not suitable according to 105.16 and 105.17. Use other suitable excavation material for backfill.

503.08 Backfill. Backfill all excavations made under this item with materials conforming to 203.02.R, except behind abutments and below the approach slabs use materials conforming to Item 203 Granular Material Type B.

Place and compact the backfill materials according to 203.06 and 203.07, except as modified by this subsection.

Do not place backfill material against any structural element until the Engineer has approved the element.

In bridge abutment areas compact backfill material to meet the compaction requirements in 203.07. Elsewhere, compact backfill material to 95 percent of the maximum laboratory dry density.

When a test section method is used for compaction acceptance: Use compaction equipment with a total weight or a centrifugal force of least 1 ton (0.9 metric tons). Supply the manufacturers' information to verify this information. Use at least six passes to construct the production areas. Use at least 97 percent of the test section maximum dry density for acceptance of the production areas.

The Contractor does not have to place backfill material around piers that are not within the embankment area or adjacent to a roadway or a railway in thin layers or compact it, but should leave the backfill material in a neat condition with a compensating allowance made for settlement.

Backfill in front of abutments and around piers to the ground lines shown on the plans.

Backfill all structural foundation units as soon as practical after the required conditions of this subsection are met to avoid the ponding of surface water and the accumulation of debris. Simultaneously backfill in front of and behind abutments, piers, wing walls, and retaining walls.

Carefully backfill against waterproofed surfaces to avoid damage to the waterproofing material.

503.09 Method of Measurement. After the requirements of Items 201, 202, and 203 have been met, the Department will measure excavation on a lump sum basis or by the number of cubic yards (cubic meters) as follows:

A. Bounded on the bottom. Bounded bottom plane of the footing, crossbeam, or wall.

B. Bounded on the top

1. In cut sections, by the surface of the remaining ground.

2. In fill sections:

a. If excavation is performed before embankment is placed, by the surface of the original ground.

b. If excavation is performed after embankment is placed, by the surface of the embankment.

C. Bounded on the sides

1. For Unclassified Excavation, 1 foot (0.3 m) outside the outer edge of the footing, crossbeam, or wall.

2. For Rock Excavation or Shale Excavation:

a. If Rock Excavation is included in the Contract, by the outer edge of the footing or wall.

b. If rock or shale is removed as part of Unclassified Excavation Including Rock and/or Shale:

(1) Above the minimum specified depth of keying, the same as described in 503.09.C.1.

(2) For the remainder of the excavation, the same as described in 503.09.C.2.a.

For keys below footings, the Department will determine the volume of keys by the number of cubic yards (cubic meters) shown on the plans.

The Department will measure Cofferdams and Excavation Bracing on a lump sum basis.

503.10 Basis of Payment. If an Item for Cofferdams and Excavation Bracing is not included in the Contract for payment, perform work according to 503.03 and the Department will pay for Cofferdams and Excavation Bracing under the contract unit price for excavation.

The elevations shown on the plans for the bottoms of footings are considered as approximate. When excavation below plan elevation for footings is required, the Department will pay for the 3 feet (0.9 m) immediately below the plan elevation within the lateral limits described in 503.09.C.1 at the unit price bid for the class of excavation.

The Department will consider additional excavation to a maximum depth of 1 foot (0.3 m) within the lateral limits described in 503.09 as incidental to the lump

sum price. Excavation deeper than 1 foot (0.3 m) below plan elevation may be provided for as Extra Work, as described in 109.05.

If Cofferdams and Excavation Bracing is a separate pay item, the lump sum price includes any extra cost involved for cofferdams for additional depth up to 3 feet (0.9 m) below plan elevation. Excavation deeper than 3 feet (0.9 m) below plan elevation and the additional cofferdams necessitated by this excavation may be provided for as Extra Work, as described in 109.05. The Contractor shall provide additional fill material and subsequent excavation to provide the minimum cover over culverts to accommodate heavy earth moving equipment at no expense to the Department.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
503	Lump Sum	Cofferdams and Excavation Bracing
503	Cubic Yard (Cubic Meter)	Unclassified Excavation
503	Lump Sum	Unclassified Excavation
503	Cubic Yard (Cubic Meter)	Unclassified Excavation Including Rock
503	Cubic Yard (Cubic Meter)	Unclassified Excavation Including Shale
503	Cubic Yard (Cubic Meter)	Unclassified Excavation Including Rock and/or Shale
503	Cubic Yard (Cubic Meter)	Rock Excavation
503	Cubic Yard (Cubic Meter)	Shale Excavation

ITEM 504 SHEET PILING LEFT IN PLACE

504.01 Description. This work consists of furnishing and driving steel sheet piling to be left in place, including furnishing and installing any specified anchors or other attachments to structures.

504.02 Materials. Furnish new sheet piling conforming to 711.03. The Contractor may use used sheet piling in good condition that conforms to project requirements provided it is inspected and approved by the Engineer.

504.03 Driving. Drive steel sheet piling to the tip elevation shown on the plans. Thread each sheet pile with adjacent sheets. Use corner piles, junction piles, and interlocking connectors as necessary so that all sheet piles are interlocked.

504.04 Method of Measurement. The Department will measure Steel Sheet Piling Left In Place [Minimum Section Modulus of ____ cubic inches per foot (____

mm³/m)] of Wall by measuring the number of square feet (square meters) in the plane of the face of the sheeting, completed and accepted in place.

504.05 Basis of Payment. The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
504	Square Foot (Square Meter)	Steel Sheet Piling Left In Place [Minimum Section Modulus of____ cubic inches per foot (____ mm³/m)] of Wall

ITEM 505 PILE DRIVING EQUIPMENT MOBILIZATION

505.01 Description
505.02 Basis of Payment

505.01 Description. This work consists of mobilizing pile driving equipment to and from the project site and, as necessary, to install the required piling.

This work includes the fixed costs that are related to the installation of the required piling.

505.02 Basis of Payment. The Department will pay for accepted quantities, after the first service pile is installed, at the contract price as follows:

Item	Unit	Description
505	Lump Sum	Pile Driving Equipment Mobilization

ITEM 506 STATIC LOAD TEST

506.01 Description
506.02 General
506.03 Test Procedure
506.04 Basis of Payment

506.01 Description. This work consists of applying a static load to a driven pile and furnishing instruments and facilities to obtain load-displacement data required to determine the ultimate bearing value of the pile. When subsequent static load tests are specified, the Office of Geotechnical Engineering will determine whether subsequent static load tests are to be performed and the location of all piles to be tested.

506.02 General. Perform the static load test according to ASTM D1143, Procedure A: Quick Test, except as modified below.

Use the hammer selected for driving the test pile to drive all piles represented by the test. If the Contractor finds it necessary to use a different hammer, the Office of Geotechnical Engineering will determine if an additional static load test is necessary.

If using anchor piles to apply the load to the test pile, locate the anchor piles to provide a minimum clear distance of 8 feet (2.5 m) from the test pile. The Contractor may use battered piles as anchor piles, provided the horizontal forces in the anchor system are balanced and excessive bending stresses are not induced in the piles. The Contractor may also use bearing piles meeting these requirements as anchor piles. After the test has been completed, remove or cut off at least 1 foot (0.3 m) below the bottom of the footing or finished surface of the ground all anchor piles outside the limits of the footing. Cut off anchor piles, other than bearing piles, within the limits of the footing 3 inches (75 mm) above the bottom of the footing. Redrive all bearing piles used as anchor piles that are displaced upward during the application of the test load according to the plan requirements.

For the duration of the test, provide adequate facilities to record load and displacement readings. To avoid column buckling of the pile, ensure that tested piles are substantially vertical and that the load is applied to the pile at a point as near the ground surface as possible.

Provide equipment and loading apparatus to apply a maximum test load of twice the ultimate bearing value. Have a Registered Engineer design the loading apparatus. Determine if piles on the plan order list for cast-in-place reinforced concrete piles have a pile wall thick enough to support the maximum test load of twice the ultimate bearing value. The minimum pile wall thickness to support twice the ultimate bearing value is:

$$t\ (\text{inch}) = \frac{2\ R\ (\text{lb})}{113{,}000\ D\ (\text{inch})} \qquad t\ (\text{mm}) = \frac{2\ R\ (\text{N})}{780\ D\ (\text{mm})}$$

Where:

t = pile wall thickness in inches (mm)
R = ultimate bearing value in pounds (N)
D = diameter of pile in inches (mm)

If the pile wall thickness for the test pile is less than t, before performing the static load test, either drive a test pile with a thicker pile wall, or fill the pile with concrete and allow the concrete to cure for 5 days. The static load test is unacceptable if the pile fails internally during the test due to improper installation or procedure by the Contractor.

506.03 Test Procedure. Apply the load at least 5 days after placing concrete in the pile or 72 hours after driving both the test pile and the anchor piles.

Use displacement indicators as the primary system to measure axial movement of the test pile top, with a redundant secondary system as described in ASTM D1143.

Apply the test load in increments of approximately one-tenth the ultimate bearing value. Between each load increment, keep the test load constant for 15 minutes. Add load increments until the test load reaches twice the ultimate bearing value or until continuous jacking is required to maintain the test load. Remove the test load in five approximately equal decrements, keeping the test load constant for 15 minutes between decrements. If it is necessary to remove and reapply the load during the test, use the same loading procedure to reapply the test load.

Record test readings taken at 1, 2, 4, 8, and 15 minutes after completing application of each load increment. Record test readings taken at 1 and 15 minutes after each load decrement and after removing all load from the test pile.

Determine the load test ultimate bearing value (Q_f) using the Davisson criteria. First plot the displacement versus load on the pile (Q). Next, draw a line representing the theoretical elastic deformation of the pile, using the following equation.

$$d = \frac{Q\,L}{A\,E}$$

Where:

d = Elastic deformation of pile in inches (mm)
Q = Test load in pounds (N)
L = Length of pile in inches (mm)
A = cross-sectional area of pile in square inches (mm^2)
E = Elastic modulus of pile in lb/in^2 (MPa)
for steel E=29,000,000 lb/in^2 (200,000 MPa)

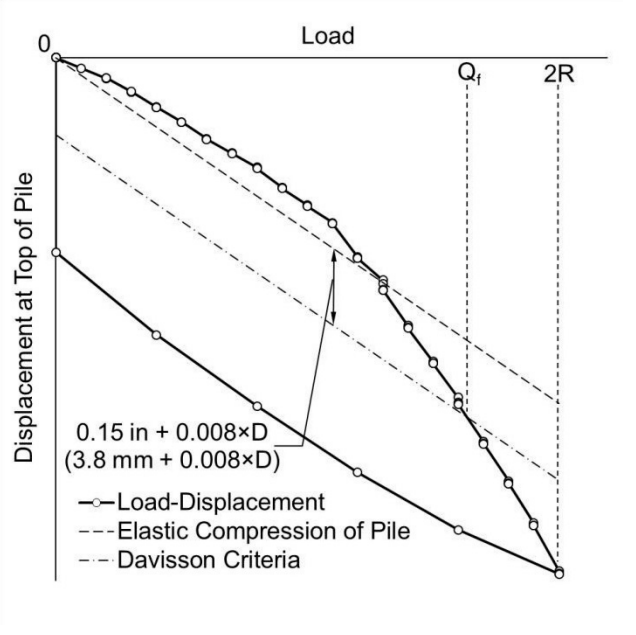
Draw the Davisson criteria line parallel to the theoretical elastic deformation but offset by the following formula:

0.15 inch + 0.008×D (3.8 mm + 0.008×D)

Where:

D = Diameter or width of the pile in inches (mm).

The test load ultimate bearing value (Q_f) is the load corresponding to where the Davisson criteria line crosses the load-displacement curve. See the figure below.



Within four days of completing the static load test, submit a report to the Engineer which contains the information required according to ASTM D 1143 and the load displacement graph described above.

506.04 Basis of Payment. If the Contractor subsequently finds it necessary to use a different hammer, the Office of Geotechnical Engineering will determine if an additional static load test is necessary; the Contractor shall complete any such additional test at no additional cost to the Department.

The cost of furnishing test piles with thicker pile walls is included under Static Load Test.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
506	Lump Sum	Static Load Test
506	Each	Subsequent Static Load Test

ITEM 507 BEARING PILES

507.01 Description. This work consists of furnishing and driving bearing piles.

507.02 General. Install piles of the specified type, length, and sizes shown on the plans. Furnish the piles according to the itemized order list shown on the plans. If additional length is needed to obtain bearing, furnish the additional length as determined by the Engineer. The length of the piles given in the order list is not necessarily based on available or practical lengths, but the estimated length from the bottom of each pile to the elevation of the cutoff. The Contractor may increase or decrease the pile lengths to suit the lengths available, to facilitate the method of operation, which may involve providing fresh heading as a result of hammer misalignment or a worn hammer cushion, or to provide lengths determined practical to have delivered to the project site and driven.

507.03 Materials. Furnish materials conforming to the following:

Reinforcing steel 509
Concrete, Class QC1 511

Chemical admixture for concrete, Type F 705.12
Steel H-piles 711.03
Steel pile points 711.07
Steel for reinforced concrete piles.....711.03
Galvanized steel..... 711.02
Timber..... 711.26

Provide a concrete slump from 6 to 8 inches (150 to 200 mm) with the use of a superplasticizer.

507.04 Driving of Piles. Drive piles to refusal on bedrock; until obtaining the required ultimate bearing value, which may include a modification for scour, set-up, or negative skin friction; or to the minimum penetration pile tip elevation shown on the plans.

If piles begin to crush, immediately cease driving and repair or replace the pile. The counting of blows will cease until the crushed pile is either repaired or replaced.

For piles subject to scour, notify the DGE if the required ultimate bearing value is obtained before the pile has penetrated 80 percent of its estimated depth before appreciably overdriving the pile. The DGE will study the conditions and determine the final penetration, the driving requirements, the use of another pile type, and the use of prebored holes.

All piles raised during the driving of adjacent piles shall be driven down again.

Use a hammer that will achieve the required ultimate bearing value for the pile and large enough to permit a dynamic load test to verify that the ultimate bearing capacity shown on the plans can be achieved.

The ram of an air-operated or diesel hammer shall weigh at least 2700 pounds (12,000 N).

The ram of a drop hammer for permanent piles shall weigh at least 3000 pounds (13,300 N). The height of fall for drop hammers shall not exceed 7 feet (2.1 m). Do not use drop hammers to drive piles that are to be driven to an ultimate bearing value in excess of 70 tons (620 kN).

When using open ended diesel hammers, provide electronic equipment, such as a saximeter, or equivalent, for the Engineer's use to accurately measure and record the stroke for each unit of length driven .

Attach a gage to closed end diesel hammers, accessible to the Engineer, to monitor the pressure in the bounce chamber. Include a graph with the gage to convert pressure to energy.

Attach an impact energy monitor, or a method to accurately measure the stroke within 2 inches (50 mm) to hydraulic hammers, accessible to the Engineer, to monitor the energy of each blow.

Use securely anchored driving leads and a cap device with sliding jaws to engage the leads to guide the pile and maintain the pile alignment with the stroke of the hammer. Accurately align the travel of the hammer with the axis of the pile.

Cushion the hammer and pile to prevent the impact of driving forces from damaging the top of the pile. Shape the cap and pile top to uniformly distribute the hammer blow to the top surface of the pile.

Do not use a follower unless approved by the Office of Geotechnical Engineering. If the Office of Geotechnical Engineering does approve the use of a follower, account for the increased energy loss when determining the required driving criteria.

If a static load test is required, the Contractor may not drive piles except the test and anchor piles before conducting the test and the required depth of penetration has been determined.

Do not use water jets.

After being driven, cut off the piles at the elevation and angle shown on the plans. Ensure that the actual pile embedment into the concrete is within 2 inches (50mm) of the embedment shown in the plans.

Maintain a minimum radius of 15 feet (4.5 m) between simultaneous work of placing concrete and driving piles. If concrete is placed within the 15-foot (4.5 m) radius, suspend driving operations until the concrete has cured for 5 days.

507.05 Determination of Required Driving Criteria. Determine the required driving criteria to achieve the ultimate bearing value of a driven pile as if the pile was a single isolated pile using the results of dynamic pile testing as specified in Item 523. The driving criteria may consist of a minimum blow count with a minimum hammer stroke, a minimum depth of penetration, or both.

To determine the minimum blow count for battered piles, divide the minimum blow count for vertical piles with the same ultimate bearing value by an efficiency factor (D) that is less than one. This will result in an increased minimum blow count for the battered piles. Compute the efficiency factor (D) as follows:

$$D = \frac{1 - (U \times G)}{(1+G^2)^{0.5}}$$

Where:

U = Coefficient of friction
use 0.05 for double-acting air operated or diesel hammers,
use 0.1 for single-acting air operated or diesel hammers, and
use 0.2 for drop hammers.

G = Amount of batter (H/V; 1/3, 1/4, etc.)

507.06 Cast-in-Place Reinforced Concrete Piles. Provide cast-in-place reinforced concrete piles with a plain cylindrical casing conforming to 711.03. Measure the pile diameter to the outside diameter of the casing.

Ensure that the pile casings are watertight after being driven. If furnished, shoes or points shall not project more than 1/4 inch (6 mm) outside the vertical surface of the casing.

The nominal pile wall thickness is the greater of either 0.250 inches or the minimum thickness specified in the project plans

For cast-in-place piles containing reinforcing steel, place reinforcing steel as stated in the second and third paragraph of 524.09 and place concrete according to 524.11.

After installation, cover the tops of driven casings until the concrete is placed. Before placing concrete, remove accumulated water or other foreign matter in a driven casing. Place concrete for cast-in-place piles using methods that prevent voids, however, do not vibrate the concrete.

507.07 Steel H-Piles. Steel H-piles shall consist of structural steel shapes of the kind and size specified.

The Engineer may allow installation of steel piles of the specified type, which the Contractor has from previous projects or stock, if the Contractor furnishes mill certifications and the pile sections are identified with the material specification number, grade, and heat number. This identification may be in the form of information painted on the steel piles or a tag physically attached to the steel.

507.08 Timber Piles. Provide timber piles of sufficient length to remove broomed or split portions caused by driving. Symmetrically trim piles right truncated cone at the tip. If steel shoes or points are specified, carefully shape the tip of the pile so that the steel shoe or point fits snugly and symmetrically.

Handle and store timber piles to prevent warping.

If specified, provide creosoted piles conforming to 712.06.

507.09 Splices. To the fullest extent practical, avoid splicing steel casings and structural shapes. Splice pile casings and structural shapes either before or after driving a segment. If spliced after driving a segment, splice the piles at least 3 feet (1 m) above the ground and inspect the splice while the pile is driven a minimum of 150 blows.

Align segments to make the axis of all segments common.

Use full penetration butt welds to splice steel pile casings according to AWS D1.1 and structural shapes according to AWS D1.5. Non-destructive testing is not required.

Do not splice timber piles.

Pile Points. When specified in the plans, select a product from the Department's approved list. Weld the pile points to the pile according to AWS D1.5 or the manufacturer's written welding procedure supplied to the Engineer before the welding is performed. Submit a notarized copy of the mill test report to the Engineer.

507.10 Defective Piles. Install the piles, so that after driving, they are within 12 inches (300 mm) from the location shown on the plans for piles capped below final grade, and within 3.0 inches (75 mm) from the plan location for pile caps above the ground surface. Piles not meeting these location tolerances are defective piles.

Pipe piles are defective if not water tight or if damage reduces the cross-sectional area by more than 20 percent. Provide the Engineer with a light that allows inspection of the entire length of the interior of a driven casing.

Replace, repair, or drive a substitute pile beside the defective pile. The location tolerance for underground piles does not apply to substitute piles beside defective underground piles. The off-location limits do apply to the substitute pile that project above the ground. If a defective pile is removed, fill the hole remaining in the ground with sand. Cut off a defective pile left in place under a footing 3 inches (75 mm) above the elevation of the bottom of the footing. Cut off a defective pile left in place but not under a footing at least 1 foot (0.3 m) below ground level. Fill defective pipe piles left in place with concrete.

When the outside rows of bearing piles are not located within tolerances specified above, increase the size of the footing to provide a minimum distance between the pile and footing edge of at least 75 percent of that shown on the plans.

507.11 Prebored Holes. Locate prebored holes as shown on the plans. Provide augured hole diameters:

A. For round piles, from 2 inches (50 mm) less to 4 inches (100 mm) more than the pile diameter.

B. For steel H-piles, from 6 inches (150 mm) less to 2 inches (50 mm) more than the pile's diagonal dimension but shall be such as to produce satisfactory pile driving results.

Backfill voids between the pile and the prebored hole with a granular material satisfactory to the Engineer.

507.12 Method of Measurement. The Department will measure piles driven by the number of feet (meters). The Department will determine the sum as the lengths of all non-defective piles measured along the axis of each pile from the bottom of each pile to the elevation of cutoff. Unless a separate pay item is specified in the Contract, the Department will include Steel Points or Shoes in the measured length of driven piles. If a separate pay item is specified in the Contract, the Department will measure Steel Points or Shoes by the number of each.

The Department will measure piles furnished by the number of feet (meters) of plan specified order length plus any additional order length specified by the Engineer. The Engineer will include the length of undriven piles as furnished, but the Contractor will not receive additional compensation for hauling the piles off the project.

For plan specified prebored holes, the Department will measure Prebored Holes by the number of feet (meters) of prebored hole lengths for non-defective piles measured from the surface of ground at the time of boring to the bottom of the hole. The Department will not measure preboring to facilitate the pile driving operation.

507.13 Basis of Payment. When the Contractor elects to prebore to facilitate the pile driving operation, include the cost for preboring in the unit price bid for piles driven.

The Department will consider the cost of furnishing and installing the reinforcing steel to be included in the unit price bid for piles driven.

The Department will not pay for any splices due to the Contractor furnishing pile lengths shorter than plan order lengths. The Department will not pay for increased

pile lengths made by the Contractor unless the Engineer determines that the additional lengths are needed to achieve bearing. If additional penetration is necessary in order to achieve the required bearing, the Department will pay for required splices at a negotiated price.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
507	Foot (Meter)	Steel Piles HP____×____, Furnished
507	Foot (Meter)	Steel Piles HP____×____, Driven
507	Foot (Meter)	___" (___ mm) Cast-In-Place, Reinforced Concrete Piles, Furnished
507	Foot (Meter)	___" (___ mm) Cast-In-Place, Reinforced Concrete Piles, Driven
507	Foot (Meter)	Timber Piles, Creosoted
507	Foot (Meter)	Timber Piles, Untreated
507	Foot (Meter)	Prebored Holes
507	Each	Steel Points or Shoes

ITEM 508 FALSEWORK AND FORMS

508.01 Description. This work consists of designing and building of falsework and forms for the purpose of holding concrete in place until it has set up.

508.02 Falsework. Provide substantial and rigid falsework that does not unduly obstruct any waterway, highway, or railway. Arrange intermediate supports in the completed structure to produce the camber necessary to conform to the plan profile of the roadway.

Do not allow the maximum deflection in the longitudinal falsework members at the edges of the concrete deck to exceed 1/2 inch (13 mm) or the amount obtained by the following formula, whichever is greater.

$$d = \frac{S + 100}{1000} \qquad \left(d = \frac{S + 2540}{1000} \right)$$

Where:

d = the maximum deflection in inches (millimeters)
S = the distance between supports in inches (millimeters)

For transverse falsework members, and for longitudinal falsework members other than those near the edges of the deck, increase the permissible deflection obtained from the above formula by 75 percent.

To compensate for falsework deflection, build camber into the falsework. In addition to falsework defection, build the following amounts of camber into the falsework to compensate for slab deflection after falsework is released:

A. Equal to 1/800 of the span for continuous spans.

B. Equal to 0.000018 S^3 (0.016 S^3) for simple spans, where S is the length of the slab span in feet (meters) for camber expressed in inches (millimeters).

Provide camber to conform to the profile grade.

If the falsework does not rest in rock, shale, or other firm foundation material, support falsework on piling driven to sufficient penetration to carry the superimposed loads according to Item 507, but not less than 16 tons (16 metric tons) per pile. Perform dynamic load testing to determine required blow count if piles are not driven to rock. Do not use expansion anchors to support falsework on piers or abutments. Use double hardwood wedges as necessary to facilitate vertical adjustment.

Remove and replace any part of the structure made unsatisfactory by incorrect camber, settlement or form deformation.

Construct falsework for arches so it may be released gradually.

Remove falsework only after the concrete conforms to 511.14 and before final acceptance of the structure. Cut off or pull falsework piling. Cut off piles to at least the slope line, riprap line, or stream bed.

Locate the lower contact point of overhang falsework within 8 inches (200 mm) of the top of the rolled beam or steel girders bottom flange.

Submit falsework plans for cast-in-place concrete slab superstructures according to 501.05.

If a thickened edge is shown on the plans, the Contractor may develop the edge by sloping the bottom of the slab for a minimum of 9 feet (2.7 m) from the edge, instead of the section shown.

Do not place bridge railings, concrete barrier, spandrel walls, decks of arches, sidewalks and curbs, or any superimposed concrete to be completed after constructing the main supporting member or the deck until the falsework for the main supporting member has been removed or released.

For continuous concrete slab or beam superstructures, do not place concrete on a span until the falsework and forms are complete for the adjacent spans. Do not release or remove falsework from a span until the concrete in adjacent spans has been placed a sufficient length of time to meet all requirements for the removal of falsework as set forth in 511.14. For phased construction of slab superstructures, do not place concrete for a closure pour until falsework on each side of the closure has been removed. Inserts cast into prestressed members for the purposes of falsework support shall be galvanized according to 711.02 and shall be shown in the shop drawings according to 515.06. Galvanize all deck hangers not encased in concrete per 711.02.

508.03 Forms. Place all concrete in proper forms. Do not use unprotected sides of the excavation, instead of forms, unless as specified in 503.05 for rock or shale excavation. For dry excavation specified in 503.03, the Contractor may use the sheeting as forms for footings.

Construct substantial, unyielding, and mortar tight forms, designed to produce a finished concrete conforming to the proper dimensions and contours. Make forms for exposed surfaces of approved material requiring a minimum number of joints or of dressed lumber of uniform thickness using form liner approved by the Engineer. Use forms and form liners to reduce the joints showing on the finished surface to a minimum. Arrange joints to coincide with rustication grooves shown on the plans. Properly brace or tie forms together using form ties that do not allow metal within 2 inches (50 mm) of an exposed surface of the finished structure after the forms are removed. For ties in the region of exposed surfaces, use an approved insert. Remove all forms and do not allow material, except reinforcing supports specified in 509.08, to remain in the concrete.

In forming pier, intermediate, or end diaphragms for prestressed or post-tensioned concrete members, do not damage reinforcing steel, strands, or precast concrete in the placement of post installed anchors in these members. Properly brace diaphragm forms externally or use approved form tie inserts cast into these members.

For concrete decks separated by an open median or temporarily separated by a closure section, construct falsework and forms for each deck or section of deck independent of the adjacent structure or remaining superstructure.

Immediately before placing concrete, provide temporary openings at the base of column and wall forms and in the bottom of all narrow, deep members where necessary to facilitate cleaning or inspection.

Provide a 3/4-inch (20 mm) bevel on all exposed edges using a triangular strip built into the forms.

If rustication is used, fasten molding that is surfaced on all sides to the forms in such a manner that the molding remains in the concrete when the forms are removed. Do not remove this molding until the concrete has set sufficiently to prevent damage to the edges of the concrete.

If weep holes through abutments or retaining walls are shown on the plans, form weep holes to obtain a smooth circular opening between 3 and 4 inches (75 and 100 mm) and a straight gradient of 0.08 through the wall.

508.04 Oiling Forms. Before placing reinforcing steel, coat the inside of forms with non-staining mineral oil or other approved material.

508.05 Basis of Payment. The Department will not separately pay for falsework and forms. The cost of this work is included for payment in the price bid for the item for which falsework and forms are used.

The Department will not pay for removal and replacement of any part of the structure made unsatisfactory by settlement or form deformation.

Include the cost for load testing required as per 508.02 in the item for which the falsework support is used.

ITEM 509 CONCRETE REINFORCEMENT

509.01 Description. This work consists of furnishing and placing supports, mechanical connectors, tie wires, and uncoated (black), epoxy coated, galvanized, chromium, stainless steel and GFRP concrete reinforcement of the quality, type, size, and quantity designated, including steel dowels.

509.02 Materials. Furnish materials conforming to:

Epoxy coated reinforcing steel	709.00
Reinforcing steel, deformed bars	709.01, 709.03, 709.05
Spiral reinforcing steel	709.01 or 709.08
Bar mats and wire fabric	709.09, 709.10, 709.12
Plastic supports	709.15
GFRP deformed bars	705.28
Galvanized reinforcement	709.16
Chromium reinforcement	709.17
Stainless steel reinforcement	709.18
Mechanical Splice Systems	709.19

Do not substitute one type of reinforcement (uncoated, epoxy coated, galvanized, chromium, stainless steel or GFRP) for another except as noted in 709.16.

The Department will randomly sample concrete reinforcement and mechanical splices for QA testing according to their respective material specifications. Provide sufficient additional concrete reinforcement to replace that removed by the Department for sampling. Replace random samples in the structures with additional reinforcement, spliced according to 509.07.

509.03 Care of Material. Upon delivery to the project and before use, place concrete reinforcement on canvas tarps supported off the ground. Within 24 hours of delivery, cover reinforcement with canvas tarps or opaque polyethylene sheeting or other suitable opaque protective material to protect reinforcement from ultraviolet

light. Keep the reinforcement covered and free from dirt, oil, grease, or avoidable rust.

When handling reinforcement, use equipment that avoids damaging or abrading the reinforcement. Lift bundles of reinforcement with multiple pickup points. Do not drop or drag reinforcement. Prevent exposure of GFRP reinforcement to temperature above 120 °F during storage. Before placing in the concrete, ensure the reinforcement is clean and free of dirt, oil, grease, and rust. Perform necessary repairs according to 509.09 for epoxy coated reinforcement, 711.02 for galvanized reinforcement and 509.10 for GFRP reinforcement.

509.04 Method of Placing. Place concrete reinforcement in the positions shown on the plans, and firmly secure the reinforcement during the placing and setting of concrete. Tie bars in the superstructure at all intersections, except tie bars at alternate intersections where bar spacing is less than 1 foot (0.3 m) in any direction. The Contractor may place up to 25 percent of the upper longitudinal bars in a bridge deck slab beneath the upper transverse bars to support the top mat. Do not drive or force concrete reinforcement into concrete after its initially set.

Welding on reinforcing is prohibited, except as permitted by 709.10 and 709.12. The Engineer will allow the Contractor to fabricate reinforcing bar cages for prestressed beams if fabrication is done in a manner satisfactory to the Director.

Install concrete reinforcement with the following clearances from the concrete surface:

A. 2.5 inches [-0 inch, +0.5 inch] to the top of sidewalks.

B. 3.0 inches [± 0 inch] at the faces of footings placed against rock or earth**.**

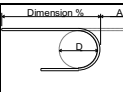
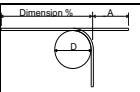
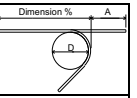
C. 1.5 inches [-0 inch, +0.25 inch] to the bottom of a cast-in-place deck slab**.**

D. 2.5 inches [-0.25 inch, +0.75 inch] to the top surfaces of cast-in-place concrete deck slabs.

E. 2.0 inches [-0 inch, +0.5 inch] at all other surfaces.

509.05 Bending. Bend concrete reinforcement to the dimensions shown on the plans and in Table 509.05-1. Reject concrete reinforcement showing transverse cracks.

TABLE 509.05-1 STANDARD BENDS

	Bar								
	Nominal Dimensions			180° Bend		90° Bend		135° Bend	
Bar	Diameter	Area	Weight	D	A	D	A	D	A
Size	in	in²	lb/ft	in	in	in	in	in	in
3	0.375	0.11	0.376	2 1/4	5	2 1/4	5	1 1/2	4
4	0.500	0.20	0.668	3	6	3	7	2	4 1/2
5	0.625	0.31	1.043	3 3/4	7	3 3/4	8 1/2	2 1/2	5 1/2
6	0.750	0.44	1.502	41/2	8	4 1/2	10		
7	0.875	0.60	2.044	5 1/4	10	5 1/4	12		
8	1.000	0.79	2.670	6	11	6	131/2		
9	1.128	1.00	3.400	9 1/2	15	9 1/2	15 1/2		
10	1.270	1.27	4.303	10 3/4	17	10 3/4	18		
11	1.410	1.56	5.313	12	19	12	20		
14	1.693	2.25	7.65	18 1/4	27	18 1/4	25		
18	2.257	4.00	13.60	24	36	24	33		

Tolerances: For diameter of bends, "D", the tolerance may be plus or minus the diameter of the bar. Standard fabricating tolerances shall be in accordance with the CRSI Manual of Standard Practice. No weight allowances will be made for tolerances. Weight applies to steel only.

509.06 Approval of Placing. Before placing concrete, obtain the Engineer's acceptance of concrete reinforcement in place.

509.07 Splicing. Splice reinforcement as specified in the Plans or determined by the Engineer. Splice spiral reinforcement by lapping 1 1/2 turns.

Splice Nos. 14 and larger reinforcing bars with mechanical splice systems. The Department will not permit lap splices for these size bars.

Splice additional reinforcement used to replace random samples as follows:

TABLE 509.07-1 - SPLICE LENGTHS FOR RANDOM SAMPLES

Bar Size	Weight (lb/ft)		Lap Length (inches)			
	Uncoated/ Galvanized/ Epoxy coated	Stainless Steel	Uncoated/ Galvanized/ Stainless	Epoxy Coated	Chromium	GFRP
3	0.376	0.374	15	17	24	26
4	0.668	0.679	19	23	32	43
5	1.043	1.048	24	29	39	46
6	1.502	1.495	29	43	47	58
7	2.044	2.038	33	50	55	65
8	2.670	2.685	38	57	63	76
9	3.400	3.396	47	70	78	97
10	4.303	4.321	58	86	96	91
11	5.313	5.296	69	104	115	n/a
14	7.650	7.640	n/a	n/a	n/a	n/a
18	13.600	13.590	n/a	n/a	n/a	n/a
20	16.690	n/a	n/a	n/a	n/a	n/a

The Department will not permit mechanical splices for GFRP reinforcement.

509.08 Supports. Use precast mortar blocks, epoxy coated, galvanized, stainless steel, or plastic supports of adequate strength, of the proper depth, and in sufficient number to support concrete reinforcement. Use Table 509.08-1 to determine allowable support material for concrete reinforcement. Space supports for concrete reinforcement no more than 4 feet apart transversely and longitudinally. Supports shall have a shape that is easily enveloped by the concrete.

TABLE 509.08-1 – ALLOWABLE SUPPORT MATERIAL

Reinforcement Material	Support Material				
	Precast Mortar	Epoxy Coated	Galvanized	Plastic	Stainless Steel
Uncoated	X	X		X	
Epoxy Coated	X	X	X	X	X
Galvanized	X	X	X	X	
Chromium	X			X	X
Stainless	X			X	X
GFRP	X			X	X

X = Allowable Support Material

Mortar blocks may only be used to support the lower mat of reinforcing steel in concrete that is cast directly against bedrock or soil.

509.09 Reinforcement Ties. Use Table 509.09-1 to determine allowable reinforcement tie material for concrete reinforcement.

TABLE 509.09-1 – ALLOWABLE REINFORCEMENT TIE MATERIAL

Reinforcement Material	Reinforcement Tie Material				
	Epoxy / PVC Coated Wire	Galvanized Wire	Plastic/ Nylon Zip Tie	Stainless Steel Wire	Thermo plastic Clips
Uncoated	X				X
Epoxy Coated	X	X		X	X
Galvanized	X	X			X
Chromium				X	X
Stainless				X	X
GFRP			X	X	X

X = Allowable Tie Material

509.10 Epoxy Coated Steel Reinforcement. Use bar supports and reinforcement ties that prevent electrical coupling between mats. Carefully handle and install bars to avoid coating damage that will require field repair. Repair all damaged coating areas where underlying steel surface is exposed. Surface rust is visual evidence of exposed steel surface. Where coating is damaged, use a wire brush or mechanical means to remove rust and loose epoxy. Repair using patching material of the same composition used or provided by the epoxy coating applicator meeting ASTM A775 except the Department will not allow aerosol spray applications.

If repair is required, clean and repair the damaged areas and allow adequate cure time before placing concrete. The Engineer will approve the installation once patching has been done as outlined above.

509.11 GFRP Reinforcement. The maximum total unrepaired visible damage on each linear foot of each GFRP bar shall not exceed 2% of the surface area in that linear foot of bar. The depth of the permissible damage shall not exceed 0.04 in. Replace the damaged bar or lap splice a new GFRP bar adjacent to the damaged portion with the appropriate lap length on either side of the damage. Do not field bend or straighten GFRP bars. Do not field cut GFRP reinforcement.

509.12 Galvanized Steel Reinforcement. Use bar supports and reinforcement ties that prevent electrical coupling between mats. Carefully handle and install bars to avoid coating damage that will require field repair. Repair all damaged coating areas where underlying steel surface is exposed. Except for damage to due field fabrication, the maximum amount of repaired damaged coating shall not exceed one percent of the total surface area in each 1-ft of bar length. Surface rust is visual evidence of exposed steel surface. Where coating is damaged, repair according to 711.02.

509.13 Chromium Steel Reinforcement. Use bar supports and reinforcement ties that prevent electrical coupling between mats.

509.14 Stainless Steel Reinforcement. Use bar supports and reinforcement ties that prevent electrical coupling between mats.

509.15 Method of Measurement. The Department will measure Epoxy Coated Steel Reinforcement, Galvanized Steel Reinforcement, Chromium Steel

Reinforcement and Stainless Steel Reinforcement, by the number of pounds shown on the Plans. The Department will measure GFRP Reinforcement by the total length in feet for each bar size specified on the Plans. Additional measurements or calculations are not required.

If the Contractor believes the pay weights or lengths, as shown on the Plans, are in error, the Contractor is responsible to prove this discrepancy by recalculating the total weight or length for the reference number involved. The Contractor shall submit its figures to the Engineer for review and approval. The number of pounds of respective steel reinforcement types shall be the actual number of pounds of the various sizes incorporated in the concrete as shown on the Plans, completed and accepted. The total length in feet for GFRP reinforcement shall be the actual number of feet of the various sizes incorporated in the concrete as shown on the Plans, completed and accepted.

If the weight of respective steel reinforcement types is recalculated, determine the number of pounds from the number, length, and weight of the bars as shown on the concrete reinforcement list of the Plans, based on the weight per foot shown in the Table 509.07-1 with deductions for bars not used, and additions for extra bars used as directed by the Engineer. If the length of GFRP reinforcement is recalculated, determine the total length in feet from the number and length for each bar size as shown on the concrete reinforcement list of the Plans with deductions for bars not used, and additions for extra bars used as directed by the Engineer.

509.16 Basis of Payment. The Department will not include the supports, mechanical connectors, and tie wires in the calculated weights or lengths but will consider them incidental to the price bid.

The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
509	Pounds	Epoxy Coated Steel Reinforcement
509	Pounds	Uncoated Steel Reinforcement
509	Feet	No.__ Deformed GFRP Reinforcement
509	Pounds	Galvanized Steel Reinforcement
509	Pounds	Chromium Steel Reinforcement, Type __
509	Pounds	Stainless Steel Reinforcement

ITEM 510 DOWEL HOLES

510.01 Description. This work consists of drilling holes into concrete or masonry, and furnishing and placing grout into the holes. The furnishing and placing of steel for dowels is included in Item 509.

510.02 Materials. Cement grout consists of one part of hydraulic cement conforming to Item 701 and three parts sand conforming to 703.03, by volume, and water.

Furnish nonshrink, nonmetallic grout conforming to 705.20.

510.03 Drilling of Holes. Drill holes at the location and the depth shown on the plans without spalling the concrete.

Drill holes for cement grout at least 1/2 inch (13 mm) larger in diameter than the dowel bar. Drill holes diameters for nonshrink, nonmetallic grout at least 1/16 inch (1.5 mm) larger in diameter than the dowel bar. Drill hole for encapsulated type nonshrink, nonmetallic grout as recommended by the manufacturer.

Instead of drilling holes, the Contractor may install formed holes with laitance removed.

510.04 Placement. Do not install grout if the temperature of the concrete into which the grout is being placed is below 40 °F (4 °C). Force dowel bars into the holes, to the specified depth, spreading the grout around the bar and solidly filling the hole.

Before installing cement grout and dowels, saturate cement grout dowel holes with water then blow out all excess water. Place enough cement grout to completely fill the holes during dowel installation. If cement grout does not completely fill the hole, remove the dowel, pour additional grout into the hole, and reinstall the dowel.

Before installing nonshrink, nonmetallic grout and dowel, clean and dry the grout holes. Immediately after mixing, place a sufficient amount of nonshrink, nonmetallic grout to provide complete coverage around the dowel to ensure anchorage. If nonshrink, nonmetallic grout does not completely fill the hole, pour additional grout in until the hole is filled flush.

Obtain the correct protrusion of the anchors or dowels, and hold dowels in the plan position within the holes until the grout has initially hardened.

If horizontal holes are specified, provide a means of retaining the grout in the hole flush with the vertical face and remove this material after the grout has hardened. Do not use material for retaining the grout that bonds to the grout.

510.05 Curing and Loading. Before applying any stresses to dowels, cure nonshrink, nonmetallic grout as follows:

Daily Minimum Ambient Temperature	Minimum Curing Time
33 to 50 °F (1 to 10 °C)	3 hours
51 to 68 °F (11 to 20 °C)	1 1/2 hours
above 68 °F (above 20 °C)	1 hour

510.06 Basis of Payment. The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
510	Each	Dowel holes with cement grout
510	Each	Dowel holes with nonshrink, nonmetallic grout

ITEM 511 CONCRETE FOR STRUCTURES

511.01 Description. This work consists of providing falsework and forming, furnishing, placing, consolidating, finishing, and curing portland cement concrete. This work also includes diamond saw cutting longitudinal grooves into the surface of superstructure concrete. Construct falsework and forms as required in Item 508.

511.02 Materials. Furnish materials conforming to 499.02, except as modified below.

Use the same kind and color of aggregate for all concrete above the ground line in a given substructure unit and for all concrete in a given superstructure.

Use high molecular weight methacrylate resin sealer conforming to 705.15.

Use curing materials conforming to 705.05; 705.06 (white opaque); or 705.07;Type 1 or 1D.

Use 1/4-inch (6 mm) gray sponge joint filler conforming to 711.28, or use preformed filler conforming to 705.03.

Use preformed elastomeric compression joint seals conforming to 705.11.

511.03 Concrete. Provide concrete for structures according to 499.03, using Class QC 1, QC 2, QC 3, or QC 4 or QC 5 as specified in the Contract.

At least 10 days before placing concrete, submit, in writing, the Department accepted Job Mix Formula (JMF) to the Engineer. The Engineer will review the mix design for conformance to contract requirements; otherwise the mix design is for the Engineer's information.

511.04 Quality Control Requirements and Mass Concrete. When the concrete bid item requires QC/QA, develop and submit a Quality Control plan (QCP) for the work and perform quality control testing of the concrete conforming to Item 455.

When the concrete bid item requires QC/QA, The Engineer will perform Quality Assurance conforming to 455.

When the concrete bid item does not require QC/QA, the Engineer will make at least one set of acceptance test cylinders for each 50 cubic yards (40 m^3) of concrete.

With any 511 concrete bid item provide and maintain a Concrete Cylinder Curing Box (CCCB) capable of holding at least twelve 4 × 8 inch (100 × 200 mm) cylinders at a temperature of 60 to 80 °F (15 to 27 °C) degrees no matter what the ambient temperature. The box will have a sealed lid. If the project has numerous 511 concrete bid items CCCB are not required for each bid item. Locate the CCCB at a site that is convenient to the concrete work and will eliminate handling damage to both the Contractor QC or QA cylinders and the Department Cylinders. Move the CCCB as needed during the project when the distance from the concrete work increases the possibility of cylinder handling damage.

A. Mass Concrete Requirements. For concrete components with a minimum dimension of 5-ft (1.5-m) or greater, develop a concrete mix design QC-4 for mass concrete according to 499.03. Develop a Thermal Control Plan (TCP) to control placement of the mass concrete so that the highest maximum internal temperature of the placed concrete is not greater than 160 °F (71 °C) and the maximum differential concrete temperature does not exceed 36 °F (20 °C) over 28 days from time of placement.

For drilled shafts with a dimension of 7-ft (2.1-m) diameter or greater, develop a concrete mix design QC-4 for mass concrete, QC 4 according to 499.03. Develop a TCP to control placement of the mass concrete so that the highest maximum internal temperature of the placed concrete is not greater than 160 °F (71 °C).

Submit the TCP to the Engineer for acceptance at least 10 calendar days prior to placement along with the approved JMF (s).

As a minimum, the TCP shall include the following information:

1. Duration and method of curing.

2. Procedures to control concrete temperature at the time of placement. The mix shall contain no frozen pieces of ice after blending and mixing components.

3. Methods and equipment used for controlling temperature differentials.

4. Temperature sensor types, locations and installation details. As a minimum, concrete temperatures shall be monitored at the calculated hottest location, on at least 2 outer faces, 2 corners, and top surfaces.

5. Temperature monitoring and recording system; operation plan; recording and reporting plan with example output; and a remedial action plan.

6. Criteria for form removal to control the maximum temperature differential.

As an alternative to the maximum differential concrete temperature specified above, the Contractor may propose maximum differential temperature limits based on strength gain with time. The TCP for the alternative proposal shall include the methods used to determine the temperature and supporting data and design to support the accuracy of the method chosen. Provide complete calculations and basis for increasing the maximum differential temperature specification. The TCP for the alternative proposal shall also provide the Engineer with tables that define ambient temperatures for acceptable concrete placement, the required temperature of the concrete for the ambient air temperature, the maximum predicted concrete temperature, the maximum predicted differential temperature, the time for removal of forms, the allowable air temperature for form removal, and the predicted maximum and differential temperature from placement to age of 28 days. The Department will consider all cracking of a mass concrete placement where the differential temperature exceeded 36 °F (20 °C) the responsibility of the Contractor.

Upon the Engineer's acceptance of the TCP, continuously monitor all temperature sensors over the required age of the concrete. If the maximum limit or differential temperature limits are exceeded at any time, immediately take action to retard and reduce the out-of-specification temperatures. If a mass concrete placement temperature exceeds the specification limits of the currently accepted TCP, re-engineer, revise and resubmit the TCP. Do not place additional mass concrete until the revised TCP is accepted.

The Department will consider in-place mass concrete that exceeds the temperature limits or that cracked, as defective and resulting delays as non-excusable. Determine the extent and effect of the damage and submit a proposed repair plan to the Engineer to return the concrete to acceptable quality. The Department will determine if the proposed repair methods are acceptable or if removal is required.

511.05 Mixing of Concrete. Mix concrete according to 499.08.

511.06 Slump. Within the slump ranges specified in 499.03, provide a slump that produces concrete that is workable in the required position, flows around reinforcing steel, and coats individual particles of coarse aggregate with mortar containing the proportionate amount of sand.

511.07 Placing Concrete. Submit to the Engineer a description of proposed placing procedures and notify the Engineer at least 24 hours in advance of placing concrete. If the concrete bid item requires QC/QA, include the submittal as part of the QCP.

Place and finish concrete to the lines and grades shown in the plans.

Unless otherwise noted, the proposed beam seat elevations shown in the plans for prestressed beam superstructures are based on the design midspan camber for prestressed beams which are 30 days old (D_{30}). Adjust each beam seat elevation using measured midspan camber data provided by the fabricator if available. In the absence of measured midspan camber, adjust each beam seat elevation using the following:

$\Delta Y = D_t - D_{30} \geq 0$

Where:

ΔY = Distance that each seat elevation shall be lowered from plan elevation to account for midspan camber growth rounded to the nearest 1/8-inch

D_t = $(1 + \psi)\, D_0$

D_{30} = Design Midspan Camber at Day 30 provided in the plans; inch

D_0 = Design Midspan Camber at Day 0 provided in the plans; inch

ψ = $1.97\, K_S\, K_F\, K_{TD}$

K_S = $1.45 - 0.13\,(V/S) \geq 1.0$

V/S = Ratio of the prestressed concrete member's volume-to-surface area exposed to the atmosphere. For each of the standard I-beam sections, this ratio is provided on PSID-1-13; inch

K_F = $5/(1 + f'_{ci})$

f'_{ci} = Compressive strength of prestressed concrete at release provided in the plans; ksi, Use the fabricator's reported strength if beams have been cast, otherwise use strength provided in the Plans.

$$k_{td} = \frac{t}{12\left(\frac{100 - 4f'_{ci}}{f'_{ci} + 20}\right) + t}$$

t = Age of prestressed concrete measured between release of prestressing force (eg. 0.75 days) and time of deck placement; days

Provide the Engineer with revised plan sheets and Design Camber calculations or measured camber data signed, sealed and dated by an Ohio Registered Professional Engineer at least 7 days prior to constructing the beam seats. The revised plan sheets shall include the measured camber data (if available), Design Camber (Dt) and beam age (t) assumed for establishing the revised elevations. Provide haunch reinforcement for prestressed I-beam members according to the ODOT Bridge Design Manual,as necessary to extend the beam's composite reinforcement at least two inches into the deck thickness. All revisions resulting from adjusted beam seat elevations shall be clearly marked as revised. Do not begin work until the Engineer approves the revised plan.

Provide coverage over or around reinforcing steel as described in 509.04.

Conform to the following tolerances from plan dimensions:

TABLE 511.07-1 - PLACEMENT TOLERANCES

Deviation from plumb for exposed surfaces	± ¾ inch (19 mm)
Vertical alignment (Deviation from a line parallel to the grade line)	± ½ inch in 20 feet (13 mm in 6 m) Max. ±1 inch (25 mm)
Longitudinal alignment (Deviation from a line parallel to the centerline or baseline)	±½ inch in 20 feet (13 mm in 6 m) Max. ±1 inch (25 mm)
Width dimensions of walls for exposed surfaces	±½ inch (13 mm)
Bridge Slab thickness	±¼ inch (6 mm)
Elevations of beam seats	±1/8 inch (3 mm)
Slope, Vertical Deviation from Plane	±0.2%
Slope, Horizontal Deviation from Plane	±0.4%

Until discharged in the work, ensure that the temperature of all concrete does not exceed 95 °F (35 °C).

When placing superstructure and approach slab concrete assure the ambient air temperature is 85 °F (30 °C) or less and not predicted to go above 85 °F (30 °C) during the concrete placement; and evaporation rates, determined according to Figure 1 in ACI 308-81, do not exceed 0.1 lbs/ft2/hour (0.5 kg/m2/hour).

Determine and document the ambient air temperature, concrete temperature, deck surface temperature, relative humidity, and wind velocity, subject to verification by the Engineer. Measure data required in Figure 1 from within 10 feet (3 m) of the area where the superstructure concrete is placed.

Figure 1 does not apply to substructure items and formed parapets. Figure 1 applies to slip-formed parapets and approach slabs.

To meet favorable atmospheric conditions, ODOT may require the Contractor to place concrete at night. At least 24 hours before placing concrete at night, submit a lighting plan for the work area to the Engineer. Obtain the Engineer's approval of the lighting plan before placing the concrete. Direct lights so that approaching traffic is not affected or distracted.

Before placing a concrete deck on continuous steel beams or girders, complete all of the main beam or girder splices at least two piers beyond the pier or piers supporting the concrete.

Before placing concrete for backwalls above the approach slab seat with steel expansion joints, backfill the abutments to within 2-feet (0.6 m) of the bridge seat elevation, erect structural steel or prestressed concrete beams and place superstructure concrete in the adjacent span. Use the steel expansion joint as a template for the top of the backwall. If temporary bolts are used to support the backwall portion of an expansion device during the placing of the backwall concrete, remove the bolts after the concrete has taken its initial set and before a change in temperature causes superstructure movement sufficient to damage the backwall.

Before placing concrete, assure the Engineer of an adequate and uniform source of supply of concrete to allow proper placing and finishing, and of the availability of coverings to protect the concrete from rain.

Do not add or apply water to the concrete after it has left the truck and before applying curing materials according to 511.14.

Before placing concrete, thoroughly clean all forms and structural steel that contact the concrete and ensure that the space to be occupied by the concrete is free of laitance, silt, dirt, shavings, sawdust, loose and built-up rust, and other debris.

Deposit concrete using methods that ensure reinforcing steel is completely enveloped in concrete mortar and that allow inspection of concrete enveloping the reinforcing steel. Use a method or device to convey the concrete from the mixer to the work that prevents coarse aggregate separating from the mortar. If depositing concrete in shallow members, such as slabs, place it with as short a vertical drop as possible. Place the concrete over a section to maintain a practically horizontal surface. If using a chute, slope the chute to allow concrete to flow without segregation. Place concrete as near as possible to its final position.

Drop concrete into the forms with a free-fall distance of 5 feet (1.5 m) or less. As necessary, use drop chutes to limit the free fall to 5 feet (1.5 m) and to ensure the delivery ends as vertical as possible.

For concrete delivered to the point of placement by means of pumping equipment, ensure the air content at the point of placement is within the specified parameters of Table 499.03-1. Adjust the pumping pressure, boom angles and use pumping aids to lower the friction in the piping to meet the specified parameters. Provide a hose at the end of the line that is at least 0.5 inch (12 mm) smaller in diameter than the line on the boom to minimize free-fall and maintain a continuous flow of concrete in the pipe lines and boom during discharge.

Deliver and distribute the concrete at a uniform and adequate rate no more than 10 feet (3 m) directly in front of the finishing machine by suitable mechanical equipment. For structures with a skew angle greater than fifteen (15) degrees, Orient the finishing machine according to 511.16. For structures with a skew angle greater than fifteen (15) degrees and up to fifty (50) degrees, load the concrete at the skew angle. For structures with a skew angle greater than fifty (50) degrees, load the concrete as close to the skew angle of the structure as possible, but do not allow the leading edge of the concrete placement to exceed twenty (20) feet (6.1 m) ahead of the finishing machine.

Place concrete in structures using vibration. Furnish and use sufficient vibration equipment of the type and size approved by the Engineer to properly compact the concrete immediately after it is placed in the forms. The vibrators shall generally be of a type that is applied directly to the concrete and have a frequency of at least 4500 impulses per minute. If the concrete is inaccessible for this method of vibration, apply the vibrators to the outside of the forms.

Do not move concrete using a vibrator. Vibrate freshly deposited concrete at the point deposited. Slowly insert and withdraw the vibrators vertically into the concrete until the concrete is thoroughly compacted but not segregated. During vibration, do not disturb partially hardened concrete.

As necessary, spade along form surfaces, in corners, and in locations impossible to reach with vibrators to ensure smooth surfaces and dense concrete. Closely

observe the results obtained on the first concrete placed, and, if necessary, modify the mix according to this specification to secure the best results.

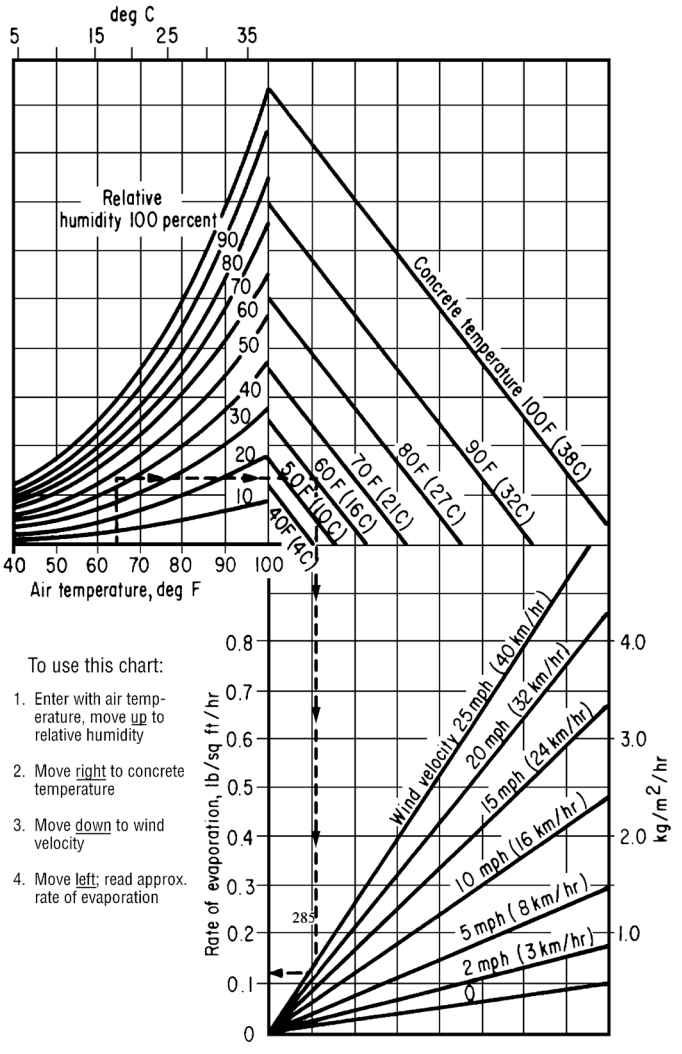


FIGURE 1 ACI 308-81

511.08 Slipform Construction of Bridge Railing. If slipforming, provide finished concrete conforming to the following tolerances from plan dimensions:

TABLE 511.08-1

SLIPFORMED BRIDGE RAILING TOLERANCES

Reinforcing steel cover	-1/2 inch, +1/2 inch (-13 mm, +13 mm)
Top width dimension	-0, +1/4 inch (+6 mm)
Bottom width dimension	-0, +1/2 inch (+13 mm)
Surface flatness	1/4 inch in 10 feet (6 mm in 3 m)
Vertical alignment (Deviation from a line parallel to the grade line)	1/2 inch in 20 feet (13 mm in 6 m) Max. ±1 inch (25 mm)

Tie all joints and splices in bridge railing reinforcing steel. Before placing concrete, perform a slipforming dry run to verify reinforcing clearance and rigidity of the reinforcing cages. Adjust and stabilize the cage as necessary to establish the required clearances and to ensure the cage will not move during slipforming. The Contractor may add any additional diagonal reinforcing steel between the front and rear vertical reinforcing faces to establish the required rigidity.

Repair or patch honeycombing, cracking, tearing, and other defects immediately after concrete exits the slipform equipment. Completely fill defects with concrete without using water to smooth or close the surface. If the slipforming exhibits more than infrequent defects, stop work and make adjustments to produce a slipformed surface that does not require repairs. Do not broom finish the surface of the bridge railings.

After the concrete initially sets, but before any shrinkage cracks develop, saw control joints 1 1/4 inches (32 mm) deep into the perimeter of the parapet. Generally, initial set is within 6 hours of batching of the concrete. Ensure that all control joints are sawed within 24 hours of placement. Saw control joints using an edge guide, fence, or jig to ensure that the joint is straight, true, and aligned on all faces of the parapet. The joint width shall be the width of the saw blade, a nominal 1/4 inch (6 mm). After the concrete curing period specified in Item 511.14 has been reached, before applying construction loads on the deck (excluding personnel, hand operated equipment and manually powered vehicles) and before allowing vehicle traffic in the lane immediately adjacent to median bridge railingsawcut each control joint at least 4 inches (100 mm) deep around the perimeter of the front face, top and back face of the top portion of parapet, no lower than 12 and ½ inches (313 mm) above the top of the concrete deck slab. Caulk the control joints with a polyurethane or polymeric material conforming to ASTM C 920, Type S.

Slip formed concrete requires different slumps than those listed in Item 499 or other plan specified concrete. Provide a slump such that the concrete exiting the slipform does not pull but is stiff enough to prevent waviness and sags in the finished surfaces. Cure slipform concrete according 511.14, Method A. Because slipformed concrete has a low water-cement ratio, timely application of the water cure is critical in helping control shrinkage cracks.

Furnish platforms as necessary to protect traffic passing under the bridge from falling debris during the slipforming operation, to allow access for completing the finishing operation, and to allow the Engineer access to the outside of the parapet.

The Engineer will inspect the slipformed surface for horizontal cracking no earlier than 21 days after completion of the slipforming operation. Repair all horizontal cracks by epoxy injection. If a concrete sealer was applied, repair damage to the sealer after completing the epoxy injection.

511.09 Construction Joints. A construction joint is a plane separating concrete placements that reach initial set at different times. Place construction joints in the locations shown in the plans. Construction joints shall have a non-finished surface, a formed finish surface or a roughened finish surface. Provide a non-finished surface on horizontal joints and a formed finished on vertical joints unless otherwise specified. A non-finished surface shall have uniformly exposed aggregate, no loose aggregate and all laitance removed. When placing concrete against an existing surface, placed in a previous project, the Department will consider the construction joint created to be a formed finish surface unless otherwise specified in the plans. All construction joint form work and bulkheads shall be in accordance with Item 508. Do not use an edger on construction joint edges. Cure the construction joints according to 511.14.

A roughened construction joint surface, when specified in the plans, shall be as follows:

A. For bonding surfaces that can be finished, finish the surface by producing groves at right angles and penetrating the finished surface approximately 1/4 ± 1/8 inch (6 ±3 mm) at a maximum spacing of 1 -1/4 ±1/4 inch (32 ± 6 mm). Grooves shall terminate approximately 1½-inches from the edge of finishing surface. If the first strike-off does not produce the required roughness, repeat the process before the concrete reaches initial set.

B. For bonding surfaces that cannot be finished according to Part A, use mechanical scarifying equipment to thoroughly roughen the existing surface to a uniformly distributed 1/4 ± 1/8 inch (6 ±3 mm) at a spacing of 1 -1/4 ±1/4 inch (32 ± 6 mm). Do not use chipping hammers heavier than the nominal 15 lb (7 kg) class and operate at an angle of less than 45 degrees with respect to the surface. Remove concrete in a manner that prevents cutting, elongating or damaging reinforcing steel.

Before placing fresh concrete against any hardened concrete surface, thoroughly clean and saturate the existing surface. Remove all loose particles, dust, dirt, laitance, oil, curing compound, concrete lip or edging, and any film of any sort. Flush construction joint surfaces with water and allow the surfaces to dry to a surface-dry condition immediately before placing concrete.

Requests to add, delete or relocate construction joints shall be in accordance with the ODOT Bridge Design Manual and shall be in writing, accompanied by revised plan sheets signed, sealed, and dated by an Ohio Registered Professional Engineer. Obtain the Engineer's acceptance prior to placing a construction joint not shown on the plans. The Department will not pay for added costs that result from such changes.

511.10 Work Stoppage. If the work is unexpectedly interrupted by breakdowns, storms, delays or other causes which will result in an initial set of the placed concrete, rearrange the freshly deposited concrete to provide a straight and non-wavy construction joint per 511.09. If the Engineer determines that this construction

joint adversely affects the structure capacity, the Engineer will require a corrective action plan per 501.05.C.

511.11 Depositing Concrete Under Water. Except for cofferdam seals and drilled shafts, do not place concrete under water.

511.12 Depositing and Curing Concrete During Cold Weather. If placing concrete when the atmospheric temperature is 32 °F (0 °C) or less, or if weather forecasts predict these temperatures during the curing period, follow the procedures of this subsection.

Heat the water or aggregate, or both, as necessary to produce concrete with a temperature when placed of at least 50 °F (10 °C) but not greater than 70 °F (21 °C).

Place concrete against materials with a temperature of greater than 32 °F (0 °C). If necessary, heat the forms, reinforcing steel, and foundation materials before placing the concrete.

Maintain the concrete surface temperature between 50 and 100 °F (10 and 38 °C) for a period of not less than 5 days, except as modified in 511.12.C. After the minimum cure period of 5 days, reduce the concrete surface temperature at a rate not to exceed 20 °F (11 °C) in 24 hours until the concrete surface temperature is within 20 °F (11 °C) of atmospheric temperature.

Install sufficient high-low thermometers to readily determine the concrete surface temperature. For deck slabs, install high-low thermometers to measure deck bottom surfaces, deck fascia surfaces, and deck top surfaces.

Maintain the concrete curing temperature using a heated enclosure, insulated forms, or by flooding, except cure deck slabs less than 10 inches (250 mm) thick using more than just insulated forms.

Remove falsework and open cold weather concrete to traffic according to 511.14.

A. Heated Enclosure. Construct the heated enclosure to surround the top, sides, and bottom of the concrete. Construct strong and wind proof enclosures that contain adequate space to allow free circulation of air around the forms and concrete.

Before placing concrete, construct the enclosure and heating devices to the extent allowed by the concrete operation. As the concreting operation progresses and as soon as possible after placing concrete, complete construction of the enclosures and apply heat. Supply heat by a method that continuously maintains a reasonably uniform temperature throughout the enclosures and does not discolor the concrete.

Vent combustion-type heating devices outside the enclosure.

If dry heat, other than free steam, maintains the enclosure temperature, immediately cover exposed concrete with two thicknesses of burlap. Continuously wet the burlap and, except for required rubbing of the concrete, do not remove the burlap during the heating period.

If wood forms without liners are left in place more than 2 days after the placing of concrete, thoroughly wet the forms at least once each day for the remainder of the heating period. If forms are removed during the heating period, thoroughly drench

the concrete with water and, for the remainder of the heating period, cover and wet the concrete with burlap as specified above.

B. Insulation. Install sufficient thermometers to readily determine the concrete surface temperature. If the surface temperature approaches 100 °F (38 °C), loosen or otherwise vent the forms or insulation to keep the surface temperature within the limits specified above. If insulation does not maintain the minimum required temperature, promptly enclose the concrete as specified in 511.12.A or flood the concrete as specified in 511.12.C.

Use a wind and water resistant insulating material. Ensure edges, corners, and other points of extreme exposure are adequately insulated. Place a tarpaulin or other Engineer approved waterproof cover over the insulation to protect the concrete top surface.

C. Flooding with Water. The Contractor may flood the concrete with water provided flooding does not damage the concrete. Heat the water to a temperature from 50 to 100 °F (10 to 38 °C). The Contractor may stop using heated water after 48 hours if the concrete remains flooded to a depth of 1 foot (0.3 m) above its highest elevation for at least the next 120 hours.

511.13 Removal of Forms. To facilitate finishing, remove forms from vertical surfaces that receive a rubbed surface finish as soon as the concrete has hardened sufficiently that rubbing will not damage it.

511.14 Curing and Loading. Remove falsework and open structures to traffic only after the concrete has reached the strength specified by Table 511.14-1A for concrete bid items requiring QC/QA. Use Table 511.14.1B for concrete items not requiring QC/QA. Do not shorten the minimum required Method A curing time regardless of strength test results.

TABLE 511.14-1A

LOADING REQUIREMENTS FOR CONCRETE REQUIRING QC/QA

<table>
<tr><th></th><th>Span[1]</th><th>Required Strength [2]</th></tr>
<tr><td rowspan="2">Removing Falsework</td><td>Any Span</td><td rowspan="3">Compressive Strength ≥ 85% f'c
or Flexural Strength (Center point)
≥ 650 psi (4.5 Mpa)</td></tr>
<tr><td>All pier caps</td></tr>
<tr><td>Traffic</td><td>Any</td></tr>
<tr><td colspan="3">[1] Span is defined as the horizontal distance between faces of the supporting elements when measured parallel to the primary reinforcement.</td></tr>
<tr><td colspan="3">[2] Field cured samples. The maturity curve method may be used for determining the strength according to Supplement 1098 in lieu of field curing samples</td></tr>
</table>

TABLE 511.14-1B

LOADING REQUIREMENTS FOR CONCRETE

NOT REQUIRING QC/QA

	Span[1]	Age of Concrete in Days	
		No Beam	Beam Test [2]
Removing Falsework	Over 10 feet (3 m)	14	5
	10 feet (3 m) or less and all pier caps	7	3
Traffic	Any	14	7
[1] Span is defined as the horizontal distance between faces of the supporting elements when measured parallel to the primary reinforcement.			
[2] Applicable only when the average modulus of rupture for two tests is not less than 650 psi (4.5 MPa).			

Take enough specimens to verify compliance with the strength requirements of Table 511.14-1A. Obtain samples from the first and last sublots of continuously placed concrete for quantities of 500 yd^3 or less, and one extra set of specimens for each additional 500 yd^3 or fraction thereof. Obtain samples in equally spaced increments throughout the placement as directed by the Engineer. Delays in placements of more than 4 hours are not considered continuously placed and are to be treated as separate placements.

If the air temperature surrounding the concrete is maintained between 32 and 50 °F (0 and 10 °C), and if the provisions of 511.12 do not apply, maintain the concrete above 32 °F (0 °C) for 7 days or until a successful strength test conforming to Table 511.14-1A, except this time shall not be less than 5 days.

Do not apply external loads to or perform work on new concrete until workers and construction materials will not damage the concrete or interfere with its curing. Allow at least 36 hours and until the field cured compressive strength cylinders or maturity results reach 85% f'c; or if using flexural beams, the average of two beam tests is greater than 650 psi (4.5 MPa) before loading new concrete.

Cure concrete as follows:

TABLE 511.14-2, CURING REQUIREMENTS

Location	Curing Method [1]
Superstructure concrete	Method A
Concrete to which sealer is applied	Method A
Construction joints	Method A
Top surface of concrete deck superstructure concrete	Method A followed by Method B
Concrete with waterproofing	Method A or Method B
All other concrete	Method A or Method B
[1] Method A is water curing. Method B is membrane curing. If using Method B on areas to be waterproofed, remove the curing membrane.	

Concrete curing methods are as follows:

A. Method A, Water Curing. With the exception of the top surface of deck superstructure concrete, protect surfaces not covered by forms immediately after final finishing with two thicknesses of wet burlap. Keep burlap wet for at least 7 days by the continuous application of water. If forms are removed before 7 days, immediately drench the exposed concrete with water and cover it with burlap. Continuously apply water to the burlap for the remainder of the curing period.

Instead of continuous application of water, with the exception of the top surface of deck superstructure concrete, the Contractor may cover the wet burlap with white polyethylene sheeting or plastic coated burlap blankets conforming to 705.06. Place plastic coated burlap blankets wet and with the burlap side against the previous layer of wet burlap. Sufficiently lap and secure adjoining plastic coated blankets or polyethylene sheets at the laps and edges to form a seal that maintains the concrete wet at laps and edges. Cover white polyethylene sheeting or plastic coated blankets containing holes or tears with an additional covering of plastic sheeting or blankets as directed by the Engineer.

Cover the top surface of deck superstructure concrete with a single layer of clean wet burlap after it is bull floated if necessary and finished. Keep the burlap wet by a continuous flow of water through soaker hoses and cover the hoses with a 4 mils (100 μm) white opaque polyethylene film for 7 days. After 7 days, allow the surface of the deck to dry.

After curing the top surface of the deck superstructure concrete for 7 days, remove the burlap and standing water. Within 12 hours after removing the burlap, apply a curing membrane and cure the concrete according to Method B.

B. Method B, Membrane Curing. Immediately after the free water has disappeared on surfaces not protected by forms, apply curing material conforming to 705.07, Type 1 or 1D. If forms are removed before the end of the 7-day curing period, apply curing material on the concrete exposed by removing the forms.

Thoroughly mix curing material immediately before use. Apply the membrane curing material at the rate of at least 1 gallon per 200 square feet (1 L/5 m^2) of surface and in a fine mist to provide a continuous, uniform, and water impermeable film without marring the concrete surface

Do not allow workers, materials, and equipment on the concrete during the curing period, unless adequately protecting the membrane curing material from damage. .

If the film is broken or damaged during the specified curing period, reapply curing material as specified above to the damaged or affected areas.

511.15 Surface Finish. For concrete that is to be sealed with Epoxy-Urethane according to 512.03, perform surface profiling and surface finish according to 512.03.F.

For all others, finish the concrete surface as detailed below:

A. Standard Finish. On all surfaces, remove fins and irregular projections with a stone or power grinder, taking care to avoid contrasting surface textures. Repair all cavities produced by form ties and, on visible surfaces, repair all defects using a mortar consisting of one part of hydraulic cement conforming to Item 499 and 1-1/2 parts sand conforming to 703.03, by volume and water conforming to 499.02 with a maximum water/cementitious ratio of 0.4. A defect is an imperfection in the concrete measuring at least 3/4" (19mm) in diameter or at least 1/2" (13 mm) deep but not exceeding a total volume of 1 cubic inch (16.387 mL). Finish all repaired surfaces on the structure in a similar manner and to the extent required to produce a uniform appearance.

B. Rubbed Finish. If a rubbed finish is shown on the plans, if possible, remove forms within 2 days after placing concrete. Finish the surface as specified above to correct defects. After the mortar used for finishing is thoroughly set, and for a minimum of 2 hours before starting the rubbed finish, thoroughly saturate the concrete with water.

Rub surfaces to be finished with a medium coarse silicon carbide stone until all form marks, projections, and irregularities are removed, all voids are filled, and a uniform surface is obtained. Leave the paste produced by rubbing in place. Other than water, do not apply additional material to the surface. After placing concrete above the finishing area, obtain the final finish by rubbing the concrete with a fine silicon carbide stone and water until the entire surface is of a smooth texture and uniform in color. Protect surfaces with a rubbed finish from damage caused by subsequent construction operations. If damaged, clean and refinish the surface as specified above.

511.16 Roadway Finish. Finish and test concrete deck slabs according to 451.13. Do not groove or broom finish a strip of surface 9 to 12 inches (220 to 300 mm) wide adjacent to curbs and barriers. Provide a broom drag finish on concrete deck slabs in the longitudinal or transverse direction.

The Engineer will approve the finishing machine. Provide a self-propelled machine with forward and reverse drive mechanisms that enable precise control of machine velocity in both directions. The machine shall have two rotating rollers, leveling augers, and either a vibrating pan or vibrating rollers. Field verify that the vibrating frequency of the pans or rollers are from 1500 to 5000 pulses per minute. Do not use vibrating rollers that have fins protruding more then 1/4 inch (6 mm) from the roller. Use a finishing machine capable of finishing transversely while traveling in both directions across the deck. Provide screeds capable of rising above

the concrete surface. Provide a finishing machine capable of finishing the full width of the decks between curbs or parapet walls. The wheels of the finishing machine shall run on temporary riding rails adequately supported on the structural steel or falsework of the deck. Make the rail and rail supports of steel and arrange the rail and rail supports so that the weight of the finishing machine and the operator cause zero vertical deflection while traveling across the deck. Ensure the rail is straight, with no sections exceeding a tolerance of 1/8 inch in 10 feet (3 mm in 3 m) in any direction. Elevate support rails a sufficient distance above the slab to allow the simultaneous hand finishing of areas not machine finished. Fabricate and install rail supports to allow removal to at least 2 inches (50 mm) below the top of the slab. Fill holes formed by the removal of rail supports during the final finishing of the slab.

For structures with a skew angle greater than fifteen (15) degrees and up to fifty (50) degrees, place the finishing machine within 5°of the skew angle of the structure. For structures with a skew angle greater than fifty (50) degrees, place the finishing machine at fifty (50) degrees.

511.17 Bridge Deck Grooving. After water curing the concrete and either before applying curing compound or some period after applying curing compound and before opening the bridge to traffic, saw longitudinal grooves into the deck, unless specified otherwise in the plans. If sawing grooves after applying the curing compound and the concrete deck is less than 30 days old, reapply the curing compound after removing standing water, within 12 hours after sawing grooves in the deck.

Use diamond blades mounted on a multi-blade arbor on self-propelled machines that were built for grooving of concrete surfaces. The groove machines shall have depth control devices that detect variations in the pavement surface and adjust the cutting head height to maintain the specified depth of the groove. The grooving machines shall have devices to control alignment. Do not use flailing or impact type grooving equipment. More than one size grooving machine may be required in order to saw the grooves as specified. Maintain a minimum of ¾ inch (19 mm) to a maximum of 2 ¼ inches (56 mm) transverse distance between adjacent passes of the grooving machine head.

Provide an experienced technician to supervise the location, alignment, layout, dimension, and grooving of the surface.

Saw grooves parallel to the bridge centerline in a continuous pattern across the surface. Begin and end sawing 9 to 12 inches (220 to 300 mm) from any device in place in a bridge deck, such as scuppers or expansion joints. Stop sawing a minimum of 2 inches (50 mm) to a maximum of 24 inches (600 mm) from skewed expansion joints. Maintain a clearance of a minimum of 2 inches (50 mm) and a maximum of 4 inches (100 mm) from the grooves to longitudinal joints in the deck. Maintain a minimum clearance of 9 inches (220 mm) to a maximum of 30 inches (750 mm) clearance between the grooves and the curb or parapet toe. However, at no point shall un-grooved portions of deck extend beyond edge line and into the temporary or permanent travelled lanes. Saw grooves in a uniform pattern spaced at 3/4 inch minus 1/4 inch or plus 0 (19 mm minus 6 mm or plus 0). Saw grooves approximately 0.15 inches (4 mm) deep and 0.10 inches (3 mm) wide.

For staged, or phase bridge deck work, saw the grooves parallel to the final, permanent bridge centerline. If the different stages or phases of the bridge deck work occur within one construction season, any stage opened to traffic shall receive an interim coarse broom finish during placement, then saw the longitudinal grooves after the final stage. The interim broom finish will not be allowed as a surface texture when opened to traffic over a winter season. Saw longitudinal grooves in the deck prior to opening to traffic for a winter season.

For bridge decks that widen from one end to the other, saw the longitudinal grooves parallel to the centerline of the roadway. On the side of the bridge that widens, saw the longitudinal grooves to follow the edge line. Saw longitudinal grooves in the gore areas, avoiding the overlapping of grooves.

At the beginning of each work shift, furnish a full complement of grooving blades with each saw that are capable of cutting grooves of the specified width, depth, and spacing.

If during the work, a single grooving blade on a machine becomes incapable of cutting a groove, continue work for the remainder of the work shift. The Contractor is not required to cut the groove omitted because of the failed blade. Should two or more grooving blades on a machine become incapable of cutting grooves, cease operating the machine until it is repaired.

Continuously remove all slurry and remaining residue from the grooving operation and leave the deck surface in a clean condition. Prevent residue from grooving operations from flowing across shoulders or across lanes occupied by public traffic or from flowing into gutters or other drainage facilities. Remove solid residue before the residue is blown by passing traffic or by wind.

Provide water as necessary to saw grooves according to this subsection.

511.18 Sidewalk Finish. After placing, strike off the concrete with a template and finish the concrete with a float to produce a sandy texture.

511.19 Joints, Cracks, Scaling and Spalls. After completing all curing operations and allowing the deck to thoroughly dry, seal the following areas with a high molecular weight methacrylate (HMWM) sealer. Flood the areas and squeegee off the excess material as specified in Item 512 before opening the deck to traffic:

A. Transverse joints in the deck.

B. Joints between the concrete deck and steel end dams.

C. Longitudinal joints in the deck.

D. Longitudinal joints between the deck and safety curb, barriers, and parapets, etc.

E. Portable barrier anchor locations.

F. Cracks discovered in the deck of the top and bottom surfaces before opening the deck to traffic, that are 10 mils or 0.010 inches or less in width. For deck cracking on the top and bottom surface area, on more than 20% of the surface area, or that is 10 mils or 0.010 inches or more in width, or deck scaling that is greater than 0.250 inches deep, or on more than 20% of the deck surface area, or deck spalling on more

than one area, or an area greater than 32 square yards, an investigation will be performed by OMM and proceed according to 108.02 to resolve the issue.

511.20 Compressive Strength. Sample and test concrete strength according to 511.04.

A. Concrete Requiring QC/QA. When the bid item requires QC/QA, the Engineer will evaluate the QC compressive test sublot results according to Supplement 1127 and as follows:

If a single reported compressive strength test result for a sublot of concrete is less than 88% f'c reevaluate the in place concrete as follows.

The Engineer will determine the location for evaluating the strength of the sublot represented by the low compressive strength concrete. Evaluate using either nondestructive testing or cores. The Engineer will accept the concrete if the reported nondestructive test results are greater than the specified f'c. The Department will use the original cylinder results for calculating the compressive strength pay factor (PFc) if non destructive testing is used. If cores are tested the core results will be used in place of the original cylinder results for pay factor determination.

If the nondestructive test results are less than the specified f'c, the Department will require the concrete to be cored. The Engineer will determine the locations for the required concrete cores. Provide all concrete cores to the Engineer for testing by the Department. Patch core holes with approved patching material. If the core results are above 88% f'c, the Department will use the core strength results for calculating the compressive strength pay factor (PFc).

If the core results indicate that the compressive strength of the concrete is below 88% *f'c*, submit a plan for corrective action to the Engineer for approval. If the corrective plan is not approved, the Engineer will require the Contractor to:

1. Remove and replace the unacceptable sublot and retest the new sublot at no cost to the Department or

2. Leave the unacceptable material in place and pay for the sublot with a pay factor of 0.75.

If three or more sublot compressive strength acceptance test results are less than *f'c* but greater than 88% *f'c* the Engineer will require an investigation of the reasons for the consistent low strengths. Until the investigation is completed to the satisfaction of the Engineer no additional placements of the concrete JMF will be made. Investigations should include all facets of the concrete operation including batching, mixing, delivery, clean up, sampling, testing, quality control plan, etc. If the Engineer is unsatisfied with the results of the investigation, the JMF and the quality control plan will become not approved. Develop and submit a new JMF and quality control plan conforming to the requirements of 499.03 and 511.04. Pay factors under 511.22 for these low strength sublots will be based on the original reported cylinder strengths.

B. Concrete Not Requiring QC/QA. When the bid item does not require QC/QA, the Engineer will evaluate the strength results following the requirements of Table 511.22-2 and as follows:

If a single compressive strength test result is less than f'c the material will be considered unacceptable material and the Department will determine acceptance according to Item 106.07.

If three or more compressive strength test results are less than *f'c* the Engineer will require an investigation of the reasons for the consistent low strengths. Until the investigation is completed to the satisfaction of the Engineer no additional placements of the concrete JMF will be made. Investigations should include all facets of the concrete operation including batching, mixing, delivery, clean up, sampling, testing, etc. If the Engineer is unsatisfied with the results of the investigation, the JMF will become not approved. Develop and submit a new JMF conforming to the requirements of 499.03.

511.21 Air Content. For concrete that requires QC/QA, test the air content of the concrete according to Item 455. When QC/QA concrete is not required, the Department will test the air content as directed by the Engineer.

A. Concrete Requiring QC/QA. Any concrete with air results outside the requirements of Table 499.03-1 that is placed into the structure is unacceptable material according to item 106.07. The amount of unacceptable material will be the amount represented by the test result. Reevaluate the unacceptable material at no cost to the Department as follows:

1. Core the location containing the unacceptable concrete. Patch the core hole with approved material.

a. For concrete with high air content, test a core for compressive strength. Concrete with a minimum strength of f'c may be left in place.

b. For concrete with low air content, test the core to determine the in-place hardened air content, specific surface and spacing factor according to ASTM C 457. Remove and replace unacceptable materials with specific surface results less than 600 in^{-1} (25 mm^{-1}) or spacing factor results are more than 0.008 in (0.20 mm).

Hire an independent laboratory acceptable to the Department to perform the testing.

B. Concrete Not Requiring QC/QA. Any concrete with air results outside the requirements of Table 499.03-1 that is placed into the structure is unacceptable material, according to item 106.07. The amount of unacceptable material will be the amount represented by the test result. Reevaluate the unacceptable material at no cost to the Department as follows:

1. The Department will core the location containing the unacceptable concrete. Patch the core hole with approved materials.

a. For concrete with high air content, the Department will test a core for compressive strength. Concrete with a strength of f'c may be left in place.

b. For concrete with low air content the Department will determine the in-place hardened air content, specific surface and spacing factor according to ASTM C 457. Remove and replace unacceptable materials with specific surface results less than 600 in^{-1} (25 mm^{-1}) or spacing factor results of more than 0.008 in (0.20 mm).

511.22 Pay Factors. Apply pay factors as follows:

A. Concrete Requiring QC/QA

The Department will use pay factors based on the percent within limits (PWL) to establish a final adjusted price. The PWL will be established per lot(s) accepted in the QCP for each bid item quantity of concrete. The Department will calculate a PWL according to Supplement 1127 using either the Contractor's verified QC compressive test results or core results when the QC could not be verified. The compressive strength pay factor (PF_C) from Table 511.22-1 for the lot will be applied to each bid item represented in the lot. The Department will combine approach slab and deck concrete test results in the same lot to determine final pay factors.

TABLE 511.22-1, PAY FACTORS FOR CONCRETE REQUIRING QC/QA

PWL	PFC
85 % – 100 %	1.00
84%	0.995
83%	0.990
82%	0.985
81%	0.980
80%	0.975
79%	0.970
78%	0.965
77%	0.960
76%	0.955
75%	0.950
< 75%	See below

If the PWL value determined for the lot of concrete is below 75%, submit a plan for corrective action to the Engineer for approval. If the corrective plan is not approved, the Engineer will require the Contractor to:

1. Remove and replace the lot of unacceptable material at no cost to the Department, or

2 Leave the unacceptable material in place and pay for the lot of with a pay factor of 0.75.

B. Concrete Not Requiring QC/QA

For concrete items that the Department performs compression testing, the Department will use pay factors based on the individual compressive strength results for the quantity represented by the test results to establish an adjusted price to the items. The pay factors from Table 511.22-2 will be applied to items represented by the tests.

TABLE 511.22-2, PAY FACTORS FOR CONCRETE NOT REQUIRING QC/QA

Individual Test Results	Pay Factor (PF_C)
≥ f'c	1.00
< f'c	Follow 106.07

511.23 Method of Measurement. The Department will measure the appropriate concrete item by the number of cubic yards (cubic meters) determined by calculations from plan dimensions, in place, completed and accepted.

The Department will make deductions for portions of primary structural members embedded in concrete. The Department will not make deductions for the volume of reinforcing steel, conduits or embedded piles.

Superstructure concrete includes the concrete in deflective parapets not having a metallic railing.

The Department may measure deck concrete by either volume or area using plan dimensions.

The Department will calculate separate quantities of concrete due to unacceptable compressive strength, 511.21 and air content, 511.22.

511.24 Basis of Payment. The Department will pay for accepted quantities of concrete as follows.

Work necessary to adjust seat elevations and deck haunches for prestressed beam members is incidental to the affected structural concrete items. The Department will pay for final quantities as measured and field verified.

The Department will not pay for additional reinforcing steel required to adequately stabilize the cages.

The Department will not pay for repairs to horizontal cracks by epoxy injection or, if a concrete sealer was applied, for repairs to the sealer after the completing the epoxy injection.

The Department will not pay extra for any type of surface finish specified in 511.15, the cost being considered as included in the price bid for concrete.

If the Contractor elects to saw the deck after applying the curing compound, the Department will not pay to reapply the curing compound.

All costs for sealing as specified in 511.19 are incidental to the appropriate concrete item. The Department will not make separate payment for sealing.

The Department will not pay separately for the concrete cylinder curing box (CCCB).

The Department will not pay for the re-evaluation of low strength test results, 511.20.A.

The Department will initially pay the full bid price to the Contractor upon completing the work. The Department will calculate the final adjusted payment for each item as follows:

PF1 - The final adjusted pay per cubic yard (cubic meter) or square yard (square meter), for accepted quantities of concrete:

PF1 = (Contract Bid Price) x PF_C

PF2 - The final adjusted pay per cubic yard (cubic meter) or square yard (square meter) for unacceptable quantities of concrete due to compressive strength or low air content and allowed to stay in place, according to 511.20 or 511.21.

PF2 = (Contract Bid Price) x 0.75

Calculate the adjusted price per bid item by multiplying PF1 or PF2 by the appropriate quantities of concrete, then sum the values. Subtract the full bid price paid to the Contractor from the adjusted price to determine the difference. The Department will execute final adjustments by change order upon receipt of all test data.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
511	Cubic Yard (Cubic Meter)	Class ___ Concrete, _____
511	Cubic Yard (Cubic Meter)	Class ___ Concrete, _____ with QC/QA
511	Cubic Yard (Cubic Meter)	Class QC 1 Concrete, Substructure
511	Cubic Yard (Cubic Meter)	Class QC 1 Concrete, Substructure with QC/QA
511	Cubic Yard (Cubic Meter) Square Yard (Square Meter)	Class QC 2 Concrete, Bridge Deck
511	Cubic Yard (Cubic Meter) Square Yard (Square Meter)	Class QC 2 Concrete, Bridge Deck with QC/QA
511	Cubic Yard (Cubic Meter)	Class QC 2 Concrete, Bridge Deck (Parapet)
511	Cubic Yard (Cubic Meter)	Class QC 2 Concrete, Bridge Deck (Parapet) with QC/QA
511	Cubic Yard (Cubic Meter)	Class QC 3 Concrete, _____ with QC/QA
511	Cubic Yard (Cubic Meter)	Class QC 4 Mass Concrete, Substructure with QC/QA

ITEM 512 TREATING CONCRETE

512.05 Soluble Reactive Silicate (SRS) Concrete Treatment
512.06 Treating Concrete Bridge Decks with Gravity-Fed Resin
512.07 Sealing Cracks by Epoxy Injection
512.08 Waterproofing
512.09 Method of Measurement
512.10 Basis of Payment

512.01 Description. This work consists of sealing and treating concrete surfaces, sealing cracks in concrete, and applying waterproofing to structures.

512.02 Materials. Furnish materials conforming to:

Asphalt cement ..... 702.01 (PG 64 - 22)
Asphalt primer for..... 702.02 (RC-70 or RC-250),
waterproofing..... 702.05
HMWM Resin 705.15
Epoxy-Urethane Sealer 705.23.A
Non-epoxy Sealer 705.23.B
Soluble Reactive Silicate (SRS)..... 705.24
Gravity Fed Resin 705.25
Epoxy injection Materials..... 705.26
Sand..... 703 with the following exceptions:
Maximum moisture content of 0.5 of the percent of absorption when treated according to California Test 226.
Gradation:

Sieve Size		Total Percent Passing
No. 4	(4.75 mm)	100
No. 8	(2.36 mm)	90 to 100
No. 20	(850 µm)	5 to 15
No. 50	(300 µm)	0 to 5

Emulsified asphalt primer,..... 702.04 (MS-2, SS-1)
Asphalt for waterproofing 702.06
Hot applied joint sealer 705.04
Type 3 membrane primer 705.04
Waterproofing fabric..... 711.24
Sheet Type 2 membrane waterproofing..... 711.25
Sheet Type 3 membrane waterproofing..... 711.29

512.03 Sealing of Concrete Surfaces. This work consists of applying an approved sealer on existing and new concrete surface areas after the concrete is cured and repairs completed and cured. Apply the sealer to locations described in the plans. Apply the sealer listed in the pay item description. Choose a type of sealer if no sealer is listed in the pay item description.

A. Equipment. Use application equipment recommended by the sealer manufacturer. Use spray equipment, tanks, hoses, brooms, rollers, coaters, squeegees, etc., that are clean, free of foreign matter, oil residue and water.

B. Mixing. Mix the sealer according to the manufacturer's recommended procedures. Furnish the Engineer with the manufacturer's application instructions. Do not mix or apply the sealer until the manufacturer's written recommendations

are supplied to the Engineer. Mix and maintain materials at a uniform consistency during application.

C. Storage. Store all sealer components in tightly sealed containers, in a dry location, and as recommended by the manufacturer. Deliver unopened drums or containers of the sealer or sealer components to the job site with the manufacturer's numbered seal intact.

D. Application submittals. At least five (5) days before sealing, provide the Engineer the sealer manufacturer's written requirements for application equipment, mixing equipment, mixing procedures, mixing time, storage requirements, recoat times and temperatures, and SDS sheets.

E. Surface Condition. Apply sealers only to surfaces which are dry, free from dust, dirt, oil, wax, curing compounds, efflorescence, laitance, coatings and other foreign materials. Visually inspect all surfaces before applying sealer. Remove all structurally unsound surfaces and weak sections.

Perform all concrete patching prior to surface profiling. Perform concrete patching on areas identified by the Engineer according to 519. Cure repaired areas for at least seven (7) days.

Air dry all concrete surfaces for at least ten (10) days after completion of required curing.

For accelerated cure of precast concrete, obtain the required 28 day strength and air dry the surfaces at least ten (10) days after completing accelerated cure.

F. Surface Preparation and Profiling.

1. Non-Epoxy Sealer

Remove dust, dirt, oil, wax, curing compounds, efflorescence, laitance, coatings and other foreign materials from surfaces to be sealed.

Ensure that all wastes generated by the surface preparation operation are managed in accordance with 107.19.

If the concrete surface had curing compound applied, acid test the surface after blasting to see if the curing compound was removed. Perform the acid test for every 500 square feet (47 square meters). Use a 30%, by weight, solution of hydrochloric acid. Apply 4 to 5 drops to the concrete surface. If foaming/fizzing occurs the curing compound is removed. Rinse the tested location with an ammonia solution to neutralize the concrete area tested (1 cup ammonia to 5 gallons water).

(NOTE: Muriatic acid and ammonia can be bought in a hardware store. Muriatic acid is used to clean masonry. Only dilute by pouring the acid into the water. DO NOT pour the water into the acid.)

When surfaces show intermittent or no foaming, use chemicals or other cleaning compounds to remove the curing compounds. Only use products approved by the sealer manufacturer. Furnish the Engineer documentation of the sealer manufacturer's approval and method to test if materials are removed.

2. Epoxy-Urethane Sealer.

Remove dust, dirt, oil, wax, curing compounds, efflorescence, laitance, coatings and other foreign materials from surfaces to be sealed.

Ensure that all wastes generated by the surface preparation operation are managed in accordance with 107.19.

If the concrete surface had curing compound applied, acid test the surface after blasting to see if the curing compound was removed. Perform the acid test for every 500 square feet (47 square meters). Use a 30%, by weight, solution of hydrochloric acid. Apply 4 to 5 drops to the concrete surface. If foaming/fizzing occurs the curing compound is removed. Rinse the tested location with an ammonia solution to neutralize the concrete area tested (1 cup ammonia to 5 gallons water).

(NOTE: Muriatic acid and ammonia can be bought in a hardware store. Muriatic acid is used to clean masonry. Only dilute by pouring the acid into the water. DO NOT pour the water into the acid.)

When surfaces show intermittent or no foaming, use chemicals or other cleaning compounds to remove the curing compounds. Only use products approved by the sealer manufacturer. Furnish the Engineer documentation of the sealer manufacturer's approval and method to test if materials are removed.

After concrete has cured and forms are removed, use one or both of the following methods to produce a surface profile that feels and looks like 100 grit sandpaper or coarser. Provide the Engineer sandpaper for comparison. Perform the ASTM D7682-12, Method B, Standard Test Method for Replication and Measurement of Concrete Surface Profile Using Replica Putty to obtain a replica coupon of the prepared concrete surface on a flat, test section, on the first day of production, and as requested by the Engineer. With a micrometer, measure the surface profile obtained on the coupon, and provide the coupon to the Engineer

a. Water blast at 7000 psi (48Mpa) minimum, or

b. Abrasive blast, followed by air brooming or power sweeping, to remove dust and sand from the surface and opened pores, or

c. Use a combination of water blast and abrasive blast.

Install suitable traps, filters, drip pans and other separation devices in the cleaning equipment so oil and other foreign material are not deposited on the surface.

Fill all cavities produced by form ties and other single defects or defected areas with a prequalified trowelable mortar in accordance with Supplemental Specification 843.02 and 843.06. Provide a broom/brush finish to all trowelable mortar patches. Cure the trowelable mortar according to Supplemental Specification 843.07.

A defect is an imperfection in the concrete measuring at least 3/4" (19mm) in diameter or at least 1/2" (13mm) deep but not exceeding a total volume of 1 cubic inch (16.387 mL). A defected area is an area with a density of imperfections between 1/4" (6 mm) and 3/4" (19 mm) in diameter or between 1/4" (6mm) and 1/2" (13 mm) deep numbering 10 or more per 1 square foot (0.09 square meters) area.

Air dry for at least 10 days after completion of the manufacturer's recommended cure time for trowelable mortar. Brush abrasive blast, followed by air

brooming or power sweeping, to remove dust and sand from the surface and opened pores.

G. Application and Coverage. Do not apply sealer to surfaces with moisture. Apply the sealer between 12 and 48 hours after surface preparation by water blasting methods. Apply the sealer within 48 hours after abrasive blasting methods. Do not apply sealer if rain is anticipated within six (6) hours after application. Wait at least 12 hours after last rain event to apply sealer. Clearly mark where the sealer application stops if not continuous.

1. Epoxy-Urethane sealers

a. Apply the epoxy coat of the epoxy-urethane sealer at the coverage rate of 120 square feet per gallon (2.9 square meters per liter). Use a coverage rate of 150 square feet per gallon (3.6 square meters per liter) when the Laboratory's qualified products list for the epoxy authorizes it. Apply the urethane coat of the epoxy-urethane sealer at a rate of 200 square feet per gallon (4.8 square meters per liter). When surfaces are not smooth and flat, adjust the given coverage rates by the following formulas to determine the correct coverage rate.

(1) For surfaces using large stone liners and standard concrete = specified coverage rate (sq ft/gal [sq m/l]) × 0.8

(2) For surfaces using large stone liners and porous concrete = specified coverage rate (sq ft/gal [sq m/l]) × 0.7

(3) For surfaces using fluted liners and standard concrete = specified coverage rate (sq ft/gal [sq m/l]) × 0.5

b. Provide documentation to the Engineer that the ambient, surface and material temperature is 50 ºF (10 ºC) or above, 5 ºF higher than the dew point, and the relative humidity is 80% or below during the application of the sealer.

c. Apply with a brush, squeegee, roller or spraying equipment and as recommended by the manufacturer.

d. Apply one coat of epoxy and one coat of the urethane top coat. Time between coats shall meet the manufacturer's written recommendation provided to the Engineer during 512.03.D. Use epoxy and urethane from the same manufacturer. Achieve specified coverage regardless of the number of passes per coat.

e. Tint so the final color is Federal Color Standard No. 17778 - Light Neutral. Pigment content shall be limited so as not to reduce sealing effectiveness of the second coat. Refer to the plans for colors for specific projects.

f. Sags and runs are not acceptable in the sealer.

g. For sealed sidewalks or other horizontal surfaces with repetitive foot traffic or vehicular traffic, integrate 1 1/2 lbs per square yard (0.8 kg/m²) of silica sand into the surface of the second coat to produce a nonskid surface satisfactory to the Engineer.

2. Non-epoxy sealer

a. Apply the sealer according to the manufacturer's recommended mode of application and under the observation of the Engineer.

b. Coverage.

(1) Surfaces subject to abrasive wear (bridge decks, bridge deck shoulders and sidewalks); Minimum, one gallon (3.875 liter) of sealer for each 100 square feet (9.0 square meters).

(2) Curbs, vertical surfaces of beams and deck slabs subject to direct roadway drainage; Minimum, one gallon (3.875 liter) for each 125 square feet (11.5 square meters).

(3) Other surfaces (for example, parapets, abutments, pier caps and median dividers); Minimum, one gallon (3.875 liter) for each 150 square feet (14.0 square meters).

Stone or fluted formed concrete surfaces may require additional sealer materials for coverage.

c. Apply sealer on horizontal surfaces in a one-pass operation at the required coverage. An acceptable application procedure consists of saturating the surface and waiting a few seconds for the sealer to completely penetrate the concrete surface. Broom in the sealer if recommended by the manufacturer.

d. Apply sealer on vertical surfaces to saturate the surface. The surface is saturated when runs of 6 to 12 inches develop. Apply additional passes in 10 to 15 minute intervals until the coverage rate is achieved. Apply sealers with brush or roller if recommended by the manufacturer.

e. After 10 to 15 minutes, squeegee off excess material on smooth finished or dense concretes where the required coverage is not absorbed.

f. Tint clear non-epoxy sealers with a vanishing dye that will not damage the concrete.

g. Do not apply sealer if the ambient temperature is below 40 °F (5 °C) or will fall below 32 °F (0 °C) within 12 hours after application.

H. Test Site/Application. Apply epoxy-urethane or non-epoxy sealer to measured coverage areas, both on horizontal and vertical surfaces, and on different concrete types, demonstrating:

1. The project's visual effects for the epoxy-urethane sealer application at the required coverage rate.

2. Visually, the absorption necessary to achieve the specified coverage rate for the non-epoxy sealer. Use at least 1/2 gallon (2 liter) of sealer, following the manufacturer's recommended method of application, for the total of the test surfaces.

3. Apply to the deck, safety curb or sidewalk for the horizontal test surfaces and use an abutment parapet or pier face for the vertical test surface so different textures are tested.

I. Appearance. Epoxy-Urethane sealers: Uniform appearance and the final color shall visually match the test section. Recoating, removal and re-application or other methods recommended by the manufacturer will be required to correct final appearance. Non-Epoxy Sealers: The sealer shall result in a uniform appearance.

J. Traffic. Allow traffic on deck shoulder areas after 12 hours of drying time for an epoxy-urethane sealer. Keep traffic off a non-epoxy sealer until the sealer is dry.

K. Safety Precautions. Follow precautions defined on the manufacturer's SDS. Provide the Engineer a copy of the SDS sheet for information before any work commences.

L. Protection of Adjoining Surfaces and the Public. Protect the public during all operations, especially when applying sealer to the fascia or the underside portions of a bridge that spans an area used by the public.

During sealing, mask off, or use other means of protection, for surfaces not being sealed. Protect asphalt and mastic type surfaces from spillage and heavy overspray. Do not apply sealers to joint sealants which have not cured according to the manufacturer's instructions. Joint sealants, traffic paints and asphalt overlays may be applied to the treated surfaces 48 hours after the sealer has been applied. Protect nearby steel, aluminum or glass surfaces when non-epoxy overspray could be deposited on those surfaces.

M. Environmental Requirements. Protect plants and vegetation from overspray by covering with drop cloths.

N. Superintendent. In addition to the requirements of 105.06, the Superintendent must successfully complete a Sealing of Concrete Surfaces training prequalification course offered by the Department. The course must have been completed within the past four years and an individual course certificate must have been received by the Superintendent. Present certificate to the Engineer prior to beginning the sealing of concrete surfaces work. Work will not be permitted to begin until after the Superintendent provides a valid course certificate.

512.04 Sealing Concrete Bridge Decks with HMWM Resin. This work shall consist of preparing and treating the concrete wearing surfaces of bridge decks with a penetrating sealer in accordance with these specifications, in reasonably close conformity with the plans and the manufacturer's recommendation and as directed by the Engineer.

A. Limitations. Do not perform this work during the period beginning November 1st and ending March 31st.

B. Surface Preparation. Remove roadway dirt and debris from the area of the deck to be treated. Sweep, abrasive blast, then with the use of a manual or power broom sweep and blow with compressed air so that the surfaces to which the sealer is to be applied is dry and free of dust and dirt. Use high pressure compressed air to blow all loose material from visible cracks. Fit the cleaning equipment with suitable traps, filters, drip pans, driers and other devices to prevent oil and other foreign material from being deposited on the surface. Do not allow traffic on the clean surface prior to application of the sealer. Remove existing pavement markings using

a method as specified in 614.11.G.1.a. Remove all traces of asphalt or petroleum products and concrete curing seals by abrasive blasting prior to air sweeping.

C. Installation. Provide a compatible promoter/initiator system capable of providing the same physical qualities of the hardened resin as if promoted/initiated with 2 percent cobalt naphthanate (6 percent) and 2 percent cumene hydroperoxide. Store materials at 65 to 80 °F (18 to 27 °C). Provide a system that has a resin gel time of not less than 40 minutes to not more than 1 1/2 hours at the time and temperature of application.

Adjust the gel time to compensate for the change in temperature throughout the day. The temperature of the surfaces to be treated may range from 50 °F (10 °C) to 120 °F (49 °C). Arrange to have a technical representative on site to provide mixing proportions equipment suitability, and safety advice. Any conflict between these provisions and representative's advice shall be resolved at the job site. The technical representative shall remain at the job site until such time as he and the Engineer agree that the Contractor is qualified in all aspects of the application of the sealer.

Do not allow the promoter and initiator, if supplied separate from the resin, to contact each other directly. Do not store containers of promoter or initiators together in a manner that will allow leakage or spillage from one to contact the containers or materials of the other.

Machine application of the resin may be performed by using a two-part resin system utilizing a promoted resin for one part and an initiated resin for the other part. This two-part resin system may be combined at a spray bar through positive displacement atomization of the resin. Do not use compressed air to produce the spray.

Use appropriate cleaning and flushing of equipment, tools, etc., with an appropriate solvent, as approved by the Engineer, in such a manner to minimize personal and environmental hazards. Advise workman that the resin will soften gum rubber soles, and a face-mask should be used to protect from accidental splashes. Clothing and leather saturated with resin will harden and become useless.

Prior to resin application the surface to be treated shall be visibly dry and its temperature between 50 °F (10 °C) and 120 °F (49 °C). Do not apply the resin within 24 hours after a rain or when rain is forecast within 12 hours or when the ambient air temperature is below 50 °F (10 °C). Pre-mark the deck to control mixed material usage and to provide a rate of application of approximately 100 square feet per gallon (2.45m²/L). The exact rate shall be determined by the Engineer prior to commencing full-scale deck treatment operations.

Before using the material submit to OMM copies of the manufacturer’s certified test data showing that the material complies with the requirements of this specification. The test data shall be developed by an independent approved testing laboratory, and shall include the brand name of the material, name of manufacturer, number of the lot tested and date of manufacture. When the material has been approved by OMM, further testing by the manufacturer will not be required unless the formulation or manufacturing process has been changed, in which case new certified test results will be required. The manufacturer shall certify that the

formulation is the same as that for which data has been submitted. The state reserves the right to sample and test delivered lots for compliance.

Flood the deck surfaces resin, allowing penetration into the concrete and filling of all cracks. Limit the initiated mix of promoted resin to 5 gallons (19 L) at a time for manual application. A significant increase in viscosity shall be cause for rejection. Apply the treatment within 5 minutes after complete mixing. Redistribute excess material by squeegee or brooms within 10 minutes after application.

Take all steps necessary to prevent the resin from flowing into lanes open to traffic. Broadcast sand over the entire treated area of the bridge deck by mechanical means to affect a uniform coverage of 0.80 to 1.2 pounds per square yard (0.43 kg/m² to 0.65 kg/m²). The sand shall be uniformly graded aggregate conforming to the quality requirements of 703 and shall conform to the following limits for grading:

Sieve Size		Total Percent Passing
No. 4	(4.75 mm)	100
No. 8	(2.36 mm)	90 to 100
No. 20	(850 µm)	5 to 15
No. 50	(300 µm)	0 to 5

It is the intention of the specification to allow the use of commercially available blast sands applied by a common lawn broadcast type seeder/spreader. Place sand between 10 to 15 minutes behind the resin spreading front and before any jelling of the resin occurs. If the surface contains large deep cracks, the low-viscosity liquid could run completely through the concrete slab. Apply a second coat in these areas after the first coat has started to cure.

Before the monomer hardens, fill imperfections or spalls with standing liquid with commercial quality concrete or sandblast sand, and finished to a uniform surface. The sand shall have a maximum moisture content of 0.5 of the percent of absorption when tested in accordance to a California Test 226.

Do not permit traffic and equipment on the tested deck until it is tack free and a minimum of 6 hours have elapsed since treatment and the sand cover adheres sufficiently to resist brushing by hand. Protect the treatment from moisture for not less than 4 hours after placement.

512.05 Soluble Reactive Silicate (SRS) Concrete Treatment. This item consist of the necessary labor, materials and equipment to prepare and treat portland cement concrete surfaces with a reactive silicate sealer meeting these specifications.

A. Equipment. Use application equipment that is recommended by the manufacturer. Use spray equipment, tanks, hoses, brooms, rollers, coaters, squeegees, etc., that are thoroughly clean, free of foreign matter, oil residue and water prior to applying the treatment.

B. Cleaning and Surface Preparation. . Do not begin sealing until all concrete repairs have been completed and reached the design strength of the patch material .

Thoroughly clean the surface to remove dust, dirt, oil, wax, curing components, efflorescence, laitance, coatings and other foreign materials. Sweep, abrasive blast, then with the use of a manual or power broom sweep and blow with compressed air so that the surfaces to which the sealer is to be applied is dry and

free of dust and dirt. Use high pressure compressed air to blow all loose material from visible cracks. Obtain the approval of the manufacturer or its representative before the use of chemicals and other cleaning compounds to facilitate the removal of these foreign materials. Apply the treatment within 48 hours following surface preparation.

Fit cleaning equipment with suitable traps, filters, drip pans and other devices to prevent oil and other foreign material from being deposited on the surface.

C. Test Application. Treat a measured test coverage area on horizontal and vertical surfaces of the different components of the structure to be treated for the purpose of demonstrating the desired physical and visual effect of an application or of obtaining a visual illustration of the absorption necessary to achieve the specified coverage rate prior to final application. In the latter case, use at least 1/2 gallon (2 L) of treatment following the manufacturer's recommended method of application for the total of the test surfaces. Locate horizontal test surfaces on the deck and on the safety curb or sidewalk and locate vertical test surfaces on an abutment parapet and pier face so that the different textures are displayed.

D. Application. Apply the concrete treatment to concrete surfaces as designated on the plans. Apply the SRS by thoroughly saturating the concrete surfaces at an application rate specified by the manufacturer.

Apply the SRS when the concrete surface temperature is above 35 °F (2 °C). Use a surface thermometer on the concrete to establish the temperature of the concrete if the air temperature at the time of application is 45 °F (7 °C) or below.

Spread the SRS from puddles to dry areas.

If unable to complete the entire application continuously, note and clearly mark the location where the application was stopped.

E. Protection of Adjoining Surfaces and the Public. Protect by masking off or by other means adjoining surfaces of the structure which are not to be sealed when applying a treatment. Make provision to protect the public when treating the fascia of a bridge and/or portions of the underside of the deck of a bridge that spans an area used by the public.

Protect asphalt and mastic type surfaces from spillage and heavy overspray. Do not apply joint sealants, traffic paints and asphalt overlays to the treated surfaces until 48 hours after the treatment has been applied. Cover adjoining and nearby surfaces of aluminum or glass where there is a possibility of the treatment being deposited on the surfaces.

Protect plants and vegetation from overspray by covering with drop cloths. Follow precautions as indicated on the manufacturer's SDS.

F. Opening to Traffic. Only allow traffic on deck after the treated area does not track. If there is any unreacted material on the surface after application(s), flush with fresh water, as recommended by the manufacturer. Contain all waste according to 107.19.

512.06 Treating Concrete Bridge Decks with Gravity-Fed Resin. This work shall consist of preparing and treating the concrete bridge deck with a gravity-fed

crack welding system in accordance with these specifications in reasonably close conformity with the plans and the manufacturer's recommendations and as directed by the Engineer.

A. Limitations. Do not perform this work during the period beginning November 1st and ending March 31st.

Prior to resin application insure that the surface to be treated is visibly dry with a temperature between 40 °F (4 °C) and 100 °F (38 °C). Do not apply the resin within 24 hours after a rain, during rain, when rain is forecast within 12 hours or when the ambient air temperature is below 40 °F (4 °C).

B. Surface Preparation. First remove roadway dirt and debris from the area to be treated. Sweep abrasive blasted surfaces to which the sealer is to be applied, then manual or power broom swept and blown with compressed air so that they are dry and free of dust and dirt. Use high pressure compressed air to blow all loose material from visible cracks. Use a high pressure water blast followed by an air blast if particles are highly embedded in the cracks, to clean cracks. Fit the cleaning equipment with suitable traps, filters, drip pans, dryers and other devices to prevent oil and other foreign material from being deposited on the surface. Do not allow traffic on the clean surfaces prior to application of the sealer. Remove existing pavement markings using a method as specified in 614.11.G.1.a. Remove all traces of asphalt or petroleum products and concrete curing by the abrasive blasting prior to air sweeping.

C. Application Pre-mark the deck to control mixed material usage and to provide a rate of application of approximately 100 to 150 square feet per gallon (2.45 to 3.68 m^2/L). The Engineer will determine the exact rate but will not exceed 150 square feet per gallon (3.68 m^2/L). Flood the area to be sealed with resin. Allow the resin to penetrate into the concrete and fill all cracks. Mix the resin to a limit of 5 gallons (19 L) at a time for manual application. Reject resin with a significant increase in viscosity. Redistribute excess material by a squeegee within 10 minutes after application. Front and back movement with the squeegee is recommended over cracks and patch perimeters to enhance penetration. Take all steps necessary to prevent the resin from flowing into lanes open to traffic. Broadcast sand over the entire sealed area of the bridge deck by mechanical means to effect a uniform coverage of 1 to 2 pounds per square yards (0.54kg/m^2 to 1.08 kg/m^2).

Protect the treatment from moisture for not less than 6 hours after placement.

D. Traffic. Do not permit traffic on the treated deck until the resin is tack free, a minimum of 6 hours has elapsed since treatment, and the sand cover adheres sufficiently to resist brushing off by hand.

512.07 Sealing Cracks by Epoxy Injection. This specification covers the repair of dry, moist or wet cracks or fractures that are 2 to 100 mils (50 to 2500 µm) in thickness in reinforced concrete members. The repair is by means of an epoxy injection system. This system shall consist of a paste epoxy used to seal the surface cracks and an injection epoxy used under low pressure, 200 psi (1400 kPa) max., to penetrate and fill the cracks and bond the crack surfaces together. Material for each epoxy shall consist of a two-component modified resin bonding system. The

unmodified resin shall be known as Component A and the hardener as Component B.

Arrange to have a manufacturer's representative at the job site to familiarize him and the Engineer with the epoxy materials, application procedures and recommended pressure practice. This representative shall direct at least one complete crack or area injection and be assured prior to his departure from the project that the personnel are adequately informed to satisfactorily perform the remaining repairs.

Furnish the Engineer a copy of the manufacturer's comprehensive preparation, mixing and application instructions which have been developed especially for use with the proposed epoxy injection system. Ensure that any significant changes to these instructions which are recommended by the representative for an unanticipated situation have been approved by the Engineer prior to the adoption of such changes.

Clean concrete surfaces adjacent to the cracks to be sealed only to the extent necessary to achieve an adequate bond with the paste epoxy, and only by procedures which will not cause abrasive grits or concrete dust to penetrate the cracks. Do not permit the use of solvents or thinners in cracks or on bonding surfaces.

Install injection ports or tees in cracks to be injected. Space injection ports or tees at 6 to 12 inches (150 to 300 mm) vertically and 6 to 18 inches (150 to 450 mm) horizontally but in no case closer together than the thickness of the concrete member if full depth penetration is desired unless otherwise specified or directed. Set ports or tees in dust free holes made either with vacuum drills or chipping hammers. Seal all surface cracks in the area to be repaired, after injection ports or tees have been inserted into the holes, with paste epoxy between ports to ensure retention of the pressure injected epoxy within the confines of the member. The Department will allow an alternative procedure of sealing the cracks before the injection holes have been made. Limit the application of paste epoxy to clean and dry surfaces. Limit substrate temperatures to not less than 45 °F(7 °C) during epoxy applications.

Begin the epoxy injection at the bottom of the fractured area and progress upward using a port or tee filling sequence that will ensure the filling of the lowermost injection ports or tees first.

Establish injection procedures and the depths and spacings of holes at injection ports or tees. Use epoxy with flow characteristics and injection pressure that ensure no further damage will be done to the member being repaired. Ensure that the epoxy will first fill the innermost portion of the cracked concrete and that the potential for creating voids within the crack or epoxy will be minimized.

Remove the injection ports or tees flush with the concrete surface after the fractured area has been filled and the epoxy has partially cured (24 hours at ambient temperature not less than 60 °F (16 °C), otherwise not less than 48 hours). Roughen the surfaces of the repaired areas to achieve uniform surface texture. Remove any injection epoxy runs or spills from concrete surfaces.

Obtain two 4-inch (100 mm) diameter core samples in the first 100 linear feet (30 m) of crack repaired and one core for each 100 linear feet (30 m) thereafter. Take the core samples from locations determined by the Engineer and for the full crack

depth. Cores will be visibly examined by the Engineer to determine the extent of epoxy penetration. Repair the core holes in the concrete with material specified in 705.21.

512.08 Waterproofing

A. General. Apply an even and uniform coating of asphalt materials using brushes, squeegees, or spray equipment.

If using spray equipment, provide portable power pressure type spraying equipment capable of being moved to the location of the waterproofing operation.

Protect concrete surfaces not covered with waterproofing from overspray, spilling, or otherwise marring of the surface with the asphalt materials.

Ensure that the edge of any exposed application is sharply defined true to line with a uniform exposure.

Do not apply waterproofing fabric or membranes over attachments and hardware. Seal the discontinuities in waterproofing with Asphalt, 702.06, or hot applied joint sealer, 705.04.

B. Preparation of Surface

1. Asphalt Materials. Remove concrete projections. Using wire brushes and clear water, remove dirt and the outside film of cement. Before applying asphalt materials, ensure that the concrete is clean and dry and the concrete temperature is at least 40 °F (4 °C).

2. Membranes. Remove protrusions from the concrete. Sweep off dirt and dust, and blow the concrete clean. Fill joints or cracks greater than 3/8 inch (10 mm) wide with portland cement mortar. In addition to the above, remove oil and grease from surfaces for Type 3 membranes using water and a detergent designed to remove oil and grease from concrete. Flush residual detergent from the surface. Do not allow traffic on the cleaned surface.

C. Primer Coat. Apply the primer coat at the rate of 0.10 to 0. 20 gallon (0.50 to 1.00 L) of asphalt material per square yard (square meter).

For primer coats applied between June 1 and September 1, use asphalt primer for waterproofing or emulsified asphalt primer conforming to 512.02.

For primer coats applied between September 1 and June 1, use asphalt primer for waterproofing conforming to 512.02.

If practical, apply asphalt emulsion using spray equipment.

If subjected to traffic, spread sand on the primer coat for protection. Broom off excess sand before applying asphalt waterproofing.

D. Type A Waterproofing. This type of waterproofing consists of one primer coat and at least two coats of asphalt material conforming to 702.06 to provide a total of at least 1 gallon (5 L) of asphalt per square yard (m^2) on flat areas and at least 1/2 gallon per square yard (3 L/m^2) on vertical or sloping surfaces. Start applying the waterproofing at the lowest point, and progress to a higher elevation. Uniformly cover the surface except apply more asphalt in corners and over

construction joints. Apply the asphalt material at a temperature from 250 to 350 °F (121 to 177 °C).

E. Type B Waterproofing. This type of waterproofing consists of one primer coat, three coats of asphalt material conforming to 702.06, and two layers of waterproofing fabric conforming to 711.24 applied as follows:

1. On a clean, dry, and well-primed surface, apply a thorough coating of asphalt at a temperature from 250 to 350 °F (121 to 177 °C).

2. Apply the coating at a rate of at least 1/3 gallon per square yard (1.5 L/m²) of surface.

3. While the asphalt is hot enough to penetrate the fabric, lay the fabric according to the following:

a. Surfaces Wider than Normal Fabric Strip. For the first strip, lay a half-width [normally 18 inches (0.5 m) wide] strip of fabric. For the second strip use a full-width strip of fabric, and lap the entire width of the first strip. Lap each succeeding strip 2 inches (50 mm) more than half its full width. Lap the fabric strips in the direction of water flow.

b. Surfaces with Same Width as Fabric Strip. For the first strip, lay a full-width strip. For the second strip, lay another full-width strip, covering the first.

Lay each strip without wrinkles, folds, or pockets. Thoroughly coat the strip with asphalt for the full width of the lap before laying the succeeding strip. Each application shall entirely conceal the texture of the fabric.

4. Apply a final coat of asphalt to provide a thorough covering for the fabric.

5. For all three coats, use a total of at least 1 gallon (5 L) of asphalt waterproofing material per square yard (m²).

Lap ends of fabric strips at least 12 inches (0.3 m), and stagger the end joints.

F. Type E Waterproofing. This type of waterproofing consists of a cold applied liquid membrane waterproofing material conforming to 702.08. Apply the coating when the air temperature is 40 ºF (4 ºC) or above, on a clean and dry surface, at a rate of 20 to 30 square feet per gallon (0.49 to 0.74 m²/L) to achieve a total thickness of 55 to 65 mils (1375 to 1625 μm). Cover after cured according to the manufacturer's recommendation and within 45 days of application.

G. Type 2 Membrane Waterproofing. This type of waterproofing consists of a rubberized asphalt and peel-and-stick waterproofing membrane 711.25. Follow manufacturer's written recommendations for application of this product, which shall be provided to the project. After installing the primer coat, if required, remove the membrane's release liner and place the adhesive side on the prepared concrete surface. Lay the membrane smooth and free of wrinkles. Lap joints in membranes by at least 1 inch (25 mm). Store membrane materials indoors at temperatures not to exceed 120 °F (49 °C).

For precast concrete three- and four-sided structures, install Type 2 membrane on the exterior vertical and exterior top horizontal surfaces.

H. Type 3 Membrane Waterproofing. This type of waterproofing consists of a primer coat conforming to 705.04 and a waterproofing membrane consisting of a high density asphalt mastic between two layers of polymeric fabric conforming to 711.29. The application of this product shall follow the manufacturer's written recommendations, which shall be provided to the project.

Keep membrane and primer materials dry before installation.

Heat the membrane primer in an oil primer heated, double-jacket kettle. Use a kettle that is clean and free of other materials with any obvious buildup scraped out. The Contractor may use a single-jacket kettle if the primer is capable of being heated in direct fire to the application temperature. Heat primers within the manufacturer's recommended temperatures.

On bridges with curbs, apply the primer and membrane 3 inches (75 mm) up the curb face. On prestressed box beam bridges with no approach slab, apply the primer and membrane 6 inches (150 mm) over the ends of the beams. On prestressed and slab bridges with approach slabs, apply the primer 2 feet (600 mm) out onto the approach slab.

If the plans require a Type 3 membrane on the top exterior surface of precast concrete three- or four-sided structures, apply the primer and membrane to overlay the vertical exterior sides of the structure by 12 inches (300 mm).

Apply primer no further than 5 feet (1.5 m) in front of the membrane using a squeegee to fill all voids and imperfections. Apply membrane from the low to the high side of the surface. Apply an extra bead of primer at the edge of the membrane. Lap joints in membranes by at least 3 inches (75 mm). After installing the membrane over the entire surface, seal joints in the membrane by applying primer and smoothing with a V-squeegee. If asphalt pavement is to be placed directly over the water proofing membrane, first apply tack coat as specified in 407 without damaging the membrane.

512.09 Method of Measurement. The Department will measure Waterproofing, of the type specified, by the number of square yards (square meters) or on a lump sum basis.

The Department will measure sealing of concrete surfaces by the number of square yards (square meters) of coated area projected to a two-dimensional surface.

The Department will measure the removal of existing coatings from concrete surfaces in square yards (square meters) removed.

The Department will measure the sealing of concrete bridge decks with HMWM resin and treating concrete bridge decks with SRS as the actual area in square yards (square meters) of surfaces treated.

The Department will measure the actual length in linear feet (meters) of crack repaired by epoxy injection.

The Department will measure the removal of pavement markings using the same method of measurement as completed markings in the units designated per Item 641.

512.10 Basis of Payment. The Department will pay for accepted quantities at the contract prices as follows:

The Department will consider the cost for the obtaining and repairing the two cores used by the Engineer to determine the extent of the epoxy penetration as incidental to the work of repairing the concrete by epoxy injection.

The Department will consider the removal of dust, dirt, oil, wax, curing compounds, efflorescence, laitance, and other foreign materials as incidental to the surface preparation of the concrete surfaces to be sealed. When the surface to be sealed contains an existing coating, the Department will consider all materials, equipment and labor to remove the existing coating as incidental to the pay item Removal of Existing Coatings from Concrete. When the surface to be sealed contains pavement markings, the Department will consider all materials, equipment and labor to remove the existing pavement markings as incidental to the pay item Removal of Existing Pavement Marking.

Item	Unit	Description
512	Square Yard (Square Meter)	Sealing of concrete surfaces
512	Square Yard (Square Meter)	Sealing of concrete surfaces (non-epoxy)
512	Square Yard (Square Meter)	Sealing of concrete surfaces (epoxy urethane)
512	Square yard (Square Meter)	Sealing of concrete bridge decks with HMWM resin
512	Square yard (Square Meter)	Treating concrete bridge decks with SRS
512	Square yard (Square Meter)	Treating concrete bridge decks with Gravity-Fed Resin
512	Foot (Meter)	Concrete repair by epoxy injection
512	Square Yard (Square Meter) or Lump Sum	Type A Waterproofing
512	Square Yard (Square Meter), or Lump Sum	Type B Waterproofing
512	Square Yard (Square Meter), or Lump Sum	Type E Waterproofing
512	Square Yard (Square Meter), or Lump Sum	Type 2 Waterproofing
512	Square Yard (Square Meter), or Lump Sum	Type 3 Waterproofing
512	Square Yard (Square Meter)	Removal of Existing Coatings from Concrete Surfaces
512	Linear Feet or Square Foot (Meter or Square Meter), or Each	Removal of Existing Pavement Marking

ITEM 513 STRUCTURAL STEEL MEMBERS

513.01 Description. This work consists of preparing shop drawings, furnishing and fabricating structural steel members, nondestructive testing, fabricator performed quality control, documentation, cleaning, shop coating, and erecting structural steel and other structural metals. Prepare shop drawings and erect structural steel according to Item 501 and the additional requirements below. Shop painting shall conform to Item 514. The work also includes any work to move existing steel structures to the plan location, making necessary repairs and alterations, and connecting or joining new and old construction.

The terms “main,” “secondary,” or “detail,” as referred to in Item 513, are defined as follows: “main” refers to material, members, and fasteners that are primarily stressed by live load and structure weight; “secondary” refers to material, members, and fasteners that do not directly support live load or main members; “detail” refers to essential non-structural material, members, and fasteners.

513.02 Fabricator Approval Procedure. Select fabricators that are listed by the Department before the Contract letting date as evaluated by the Office of Materials Management and prequalified according to Supplement 1078.

The Office of Materials Management may accept subletting of processes that require specialized machinery or knowledge. Submit written requests for subletting to the Office of Materials Management. The Office of Materials Management will determine if the process is uncommon and will evaluate the qualifications of the proposed sublet fabricator. The fabricator's quality control staff shall witness and perform quality control of the sublet work.

513.03 Levels of Fabricator Qualification. There are eight levels of fabricator qualification. The Office of Materials Management will classify each fabricator at the highest level of fabrication it is qualified to perform.

Level	Description of Capabilities
SF	Standard fabricated members described and paid for as Item 516, 517, and 518 and detailed by standard bridge drawings. Material and fabrication acceptance by certification with random Department audits of the work and documentation.
UF	Unique fabricated members not covered by standard bridge drawings and not designed to carry tension live load. Examples include curb plates, bearings, expansion joints, railings, catwalk, inspection access, special drainage, or other products. Examples also include retrofit cross frames, retrofit gusset plates, retrofit lateral bracing, or other miscellaneous structural members not included in Levels 1 through 6. Quality assurance of shop drawings, material test reports, and inspection according to Supplement 1078.
1	Single span, straight, rolled beam bridges without stiffeners, Secondary and Detail materials designed to carry tension live loads such as retrofit moment plates. Case II Loading. Quality assurance of shop drawings, material test reports, and inspection according to Supplement 1078.
2	Multiple span, straight, rolled beam bridges without stiffeners. Case II loading. Quality assurance of shop drawings, material test reports, and inspection according to Supplement 1078.
3	Single or multiple span, straight, dog legged, or curved, rolled beam bridges including stiffeners. Case I or II Loading. Quality assurance of shop drawings, material test reports, and inspection according to Supplement 1078.
4	Straight or bent welded plate girder bridges. Case I or II loading. Quality assurance of shop drawings, material test reports, and inspection according to Supplement 1078.
5	Straight, curved, haunched, or tapered welded plate girder bridges. Case I or II loading. Quality assurance of shop drawings, material test reports, and inspection according to Supplement 1078.
6	Truss bridges, fracture critical bridges, fracture critical members, or fracture critical components new or retrofitted. Case I or II loading. Quality assurance of shop drawings, material test reports, and inspection according to Supplement 1078.

513.04 General.

Perform all steel fabrication including the shop application of coatings in a pre-qualified structural steel fabricating shop consisting of adequately sized permanent buildings with equipment, heat and light, and experienced personnel to satisfactorily perform all necessary operations. Perform flame cutting, air carbon-arc gouging, cambering, welding, cleaning, and painting inside permanent buildings that are maintained at the required environmental conditions. The fabricator may perform shop assembly of large pieces for fit-up of field connections outdoors. These provisions will not apply to steel requiring fabrication at the bridge site in the repair, alteration or extension of an existing structure.

If repairing, extending, or altering existing structures, take measurements of the existing structure as required to accurately join old and new work. Include these measurements on shop drawings. Measurements shown on the plans that indicate the extent and nature of repair, alterations or extension shall not relieve the Contractor of this responsibility.

At least two weeks before starting shop fabrication, the fabricator shall notify the Office of Materials Management and furnish a proposed fabrication schedule for the work.

Unless the Office of Materials Management provides a written waiver of a hold or witness point inspection, the fabricator shall store members completed during the inspector's absence in a manner that allows the inspector to completely and safely inspect the finished work.

The fabricator shall not ship fabricated members performed under Item 513, UF Level or Levels 1 through 6 from the shop without prior hold point inspections unless the Office of Materials Management waives the inspection. The Office of Materials Management will not conduct the scheduled final inspection until the fabricator completes and inspects with documentation, final fabrication and shop coatings and the Contractor documents approval of shop drawings and material test reports.

The Office of Materials Management will not conduct a final fabrication inspection of SF Level members. Instead, the Office of Materials Management will conduct random inspections during the fabricator's work.

The fabricator shall provide an office with the following attributes:

A. A minimum floor area of 120 square feet (11 m²).

B. A minimum ceiling height of 7 feet (2.1 m).

C. Adequate working and storage facilities with one locking file cabinet for the exclusive use of the Department's inspector, lighting, and electrical outlets.

D. Provisions for heating to a minimum temperature of 68 °F (20 °C) and adequately ventilated.

E. A telephone with direct access to an outside trunk line for the exclusive use of the inspector.

If using steel stamps for identification purposes, use the "mini-stress" or "stressless" type.

513.05 Fabricator Documentation Responsibility. The fabricator shall keep and maintain documentation records as specified in Supplement 1078.

At the Department's request, provide access to the above documents for audit, inspection, and copying.

513.06 Shop Drawing. Provide shop drawings conforming to 501.04 and the following requirements:

Include details, dimensions, size of materials, match mark diagrams for field connections, a diagram identifying, by some unique mark, each area of a welded splice to be covered by a single radiograph, and other information necessary for the complete fabrication and erection of the metal work.

For multiple span beam and girder bridges, include an overall layout with dimensions showing the relative unloaded vertical and horizontal position of beam or girder segments with respect to a full length base or work line. Account for camber and horizontal curvature of the beams or girders, and the effect of deck surface profile in this layout. Show required offsets for vertical and horizontal curvature at approximately each one-fourth of span length, at field splices, and at bearing points. For horizontally curved members, show the offset to a baseline strung from end to end of the member, every 10 feet (3 m) of length.

Identify the grade (ASTM designation), CVN, fracture critical, or any special testing requirements for each piece of steel. Identify pieces made of different grades of steel with different assembling or erecting marks, even if the pieces have identical dimensions and detail.

Identify the welding procedure by the WPS number at each joint and the location and identification numbers of all radiograph tests.

Detail structural steel to fit under full steel dead load and prior to deck placement with the webs of primary members plumb.

513.07 Levels 1 through 6, Prefabrication Meeting. After providing the notice and schedule required by 513.04 and at least 3 days after the Department receives shop drawings, conduct a prefabrication meeting at the fabricator's facilities, or another location agreed to by all parties. The fabricator and its quality control specialists for fabrication and painting, the inspector, and the Contractor, or its designated representative, shall attend the meeting. The purpose of this meeting is to review any fabrication issues, including information on shop drawings, inspection, hold or witness points, unique fabrication items, special processes, and both the fabrication and project schedule. The fabrication quality control specialist shall conduct the meeting and record and distribute meeting minutes that document all issues discussed. Fabrication may begin after the prefabrication meeting is complete.

513.08 Materials. Furnish materials conforming to 501.06.

513.09 Material Control. Identify and mark each piece of steel according to the shop drawings and the following requirements.

Immediately after removing steel that is furnished in tagged lifts or bundles, mark the individual pieces of steel with the ASTM A 6/A 6M specification identification color code and heat number.

The fabricator may furnish material from stock that is marked with the heat number and mill test report.

If separated from the full-size piece furnished by the supplier, mark excess material placed in stock for later use with the heat number and, if provided, with the ASTM A 6/A 6M specification identification color code.

During fabrication, clearly and legibly mark the specification identification color code and heat number on each piece of steel.

Before cutting steel into smaller size pieces, clearly and legibly mark each smaller size piece with the ASTM A 6/A 6M specification identification color code and heat number.

Unless otherwise approved by the inspector, mark pieces of steel that will be subject to fabricating operations such as blast cleaning, galvanizing, heating for forming, or other operations that may obliterate paint color code and heat number markings with steel stamps or with a substantial tag firmly attached to the piece of steel. At locations acceptable to the Office of Materials Management, stamp the heat numbers into main material tested for CVN.

Issue cutting instructions by cross-referencing the assembly marks shown on the shop drawings with the corresponding item covered on the mill purchase order. The fabricator's system of assembly-marking individual pieces of steel and issuing cutting instructions shall provide a direct reference to the appropriate mill test report.

The fabrication quality control specialist shall provide the Engineer with a letter documenting that the fabricator performed material control according to this specification.

513.10 Care of Material. Store structural material at the shop or field above the ground, upon platforms, skids, or other supports. Use straight structural steel with clean and dry surfaces before working it in the shop. Before using, clean all rusted or corroded material. Only use this material if it conforms to ASTM A 6/A 6M thickness tolerances after cleaning.

513.11 Workmanship and Straightening. If necessary to straighten rolled material, use methods that will not damage the member. If carefully planned and supervised, apply localized heat for straightening. Do not allow the temperature of the heated area to exceed 1150 °F (620 °C) as controlled by pyrometric stick or thermometers. Do not quench to accelerate cooling. Do not kink or offset the material if using mechanic or hydraulic force to camber or strengthen material. Do not cold bend fracture critical materials.

Camber rolled beams as shown on the plans in the prequalified fabricating shop using heat or hydraulic jacks. Control heating as specified above and follow a formal shop heating procedure. Camber plate girders by trimming web plates before assembly. During fabrication, shipping, and erection, support and handle members to maintain camber.

Fabricate structural steel to within the dimensional tolerances specified by Articles 3.5 of the AASHTO/AWS *Bridge Welding Code*, with the following modifications:

A. Waviness, the deviation of the top or bottom surface of a flange from a straight line or plan curvature, shall not exceed 1/8 inch (3 mm) when the number of waves in a 10-foot (3 m) length is four or less, or 1/16 inch (1.6 mm) when more than four, but sharp kinks or bends shall be cause for rejection.

B. For the measurement of camber during lay down, position the bearing points both horizontally and vertically to plan dimensions ±1/8 inch (±3 mm).

C. Measure camber as the vertical offset between the steel and the common base line extending from abutment bearing to abutment bearing. The maximum camber tolerance at mid-span shall be 0 inch (0 mm) and the greater of +3/4 inch (+19 mm) or the designed haunch height. Prorate the maximum camber tolerance at mid-span between the center of the span and each adjacent bearing to provide a smooth unbroken curve.

D. Permissible difference in horizontal curvature of top and bottom flange at any point on centerline of member, when measured as specified in 3.5.1.4, shall not exceed 3/8 inch (10 mm)

513.12 Finish. Plane sheared edges of all main material to a minimum depth of 1/4 inch (6 mm) except for ASTM A 709/A 709M, Grade 36 (250) steel having a thickness of 5/8 inch (16 mm) or less. Remove fins, tears, slivers, and burred or sharp edges from steel members by grinding. If these conditions appear during the blasting operation, re-grind and re-blast the steel members to the required surface profile.

The fabricator may flame cut structural steel. Provide a smooth surface, free from cracks and notches, and use a mechanical guide to provide an accurate profile. Roll and flame cut surfaces according to the AASHTO/AWS *Bridge Welding Code*, as amended by Supplement 1011.

Provide a surface finish for bearing and base plates and other bearing surfaces that contact each other or concrete according to ANSI B46.1, Surface Roughness, Waviness and Lay, Part I.

TABLE 513.12-1, ANSI B46.1

Steel slabs	2000 mil	(50.0 µm)
Heavy plates in contact in shoes to be welded	1000 mil	(25.0 µm)
Milled ends of compression members, milled or ground ends of stiffeners and fillers	500 mil	(12.5 µm)
Bridge rollers and rockers	250 mil	(6.4 µm)
Pins and pin holes	125 mil	(3.2 µm)
Sliding bearings	125 mil	(3.2 µm)

513.13 Stiffeners. Place the bearing end of bearing stiffeners flush and square with the web and in a manner so at least 75 percent of the area of the bearing end is in contact with the inner surface of the flange. The other end of the bearing stiffener shall have a tight fit as defined below. Position bearing stiffeners to be vertical after erection. Weld intermediate stiffeners that are not used in pairs to the compression

flange, and provide a tight fit for the tension flange. Weld stiffeners connected to cross frames and/or diaphragms to the top and bottom flange.

A tight fit is defined as the contact between the stiffener and flange over some portion of the end of the stiffener and having no gap greater than 1/16 inch (1.6 mm).

Clip stiffeners 2 1/2 inches (65 mm) along the web and 1 inch (25 mm) along the flange to clear flange-web welds and fillet or rolled shapes.

When attaching stiffeners to the web and flanges, do not extend welds to the edge of the stiffeners or into the clip area. Terminate these welds 1/4 ±1/8 inch at the flange connections and 1/2 ±1/4 inch at the web connection.

513.14 Fillers. Detail the shop drawings to show fill plates that compensate for the misalignment of abutting elements due to differences in thickness of flanges and webs at the splice locations. Detail the fill plates to the nearest 1/16 inch (1.6 mm) in thickness, but not less than 1/8 inch (3 mm) thick. However, in the final shop assembly, furnish fills of sufficient thickness to compensate for misalignment of abutting elements due to standard rolling mill tolerances or due to differences in thicknesses of flanges and webs at the splice location. The actual fills used shall compensate for differences in total thickness or relative positions of more than 1/16 inch (1.6 mm) but with no fills less than 1/8 inch (3 mm) thick. Provide fill plates in bolted joints that are flush with the perimeter of the splice plates.

513.15 Horizontally Curved Beams and Girders. If members are to be heat curved, submit the detailed procedure, including calculations to the Office of Materials Management. Obtain the Office of Materials Management's acceptance of the procedure before starting this work.

Curve beams and girders using heat according to the AASHTO-LRFD Bridge Construction Specification.

513.16 Joints and Splices. In bolted construction where tension or flexural members are spliced, maintain a clearance of not more than 1/4 inch (6 mm) between the abutting surfaces of spliced members. For spliced compression members, face the abutting surfaces to provide a uniform bearing when properly aligned and completely bolted.

In welded construction, prepare abutting surfaces as shown on the shop drawings. Verify the preparation for field welded butt joints in main members by a complete shop assembly according to 513.24.

513.17 Pin Holes. Bore pin holes after the member is fabricated and true to size, at right angles to the axis of the member and parallel to each other. Pin holes for up to 5-inch (127 mm) diameter pins shall not exceed the pin diameter by more than 0.020 inch (0.51 mm) and pin holes for larger pins shall not exceed the pin diameter by more than 0.031 inch (0.79 mm).

513.18 Pins and Rollers. Use pins and rollers made from cold rolled steel, accurately turned to size, straight and smooth, and entirely free from flaws. Pins over 9 inches (230 mm) in diameter shall be annealed. In pins larger than 9 inches (230 mm) in diameter, bore a hole not less than 2 inches (50 mm) in diameter the full length of the axis. Furnish one pilot and one driving nut for each size of pin.

513.19 Holes for High-Strength Bolts and Bearing Bolts. Provide cylindrical holes, perpendicular to the member, clean cut, and free of ragged edges. Remove burrs by countersinking not more than 1/16 inch (1.6 mm) or by grinding. Provide finished holes with a diameter not larger than the nominal diameter of the bolt plus 1/16 inch (1.6 mm). The hole diameter shall not vary by more than 1/32 inch (0.8 mm) from a true circle for 85 percent of the holes in a contiguous group, and not more than 1/16 inch (1.6 mm) for the remainder.

Punch holes using a die with a diameter not exceeding that of the punch by more than 1/16 inch (1.6 mm). Ream and drill holes using twist drills and twist reamers. Wherever possible, direct the reamer by mechanical means.

Sub-drill holes 3/16 inch (5 mm) less in diameter than the nominal diameter of the bolt, and ream the holes to size with the parts assembled, except:

A. The fabricator may sub-punch main material conforming to ASTM A 709/A 709M, Grade 36 (250) steel that is less than 3/4 inch (19 mm) thick, and Grade 50 (345) or 50W (345W) steel that is less than 5/8 inch (16 mm) thick.

B. The fabricator may drill full-size holes in materials assembled and adequately clamped together.

C. The fabricator may punch full-size holes in secondary and detail material conforming to ASTM A 709/A 709M, Grade 36 (250) steel that is less than 3/4 inch (19 mm) thick, and Grade 50 (345) or 50W (345W) steel that is less than 5/8 inch (16 mm) thick.

D. The fabricator may make assemblies such as floor beams connected to girders and rolled beam spans connected by diaphragms through steel templates.

Place all sub-punched or sub-drilled holes with sufficient accuracy such that after assembling (before reaming) a cylindrical pin 1/8 inch (3 mm) smaller than the nominal size of the punched hole may be entered perpendicular to the face of the member without drifting in not less than 75 percent of the contiguous holes in the same plane. All holes shall allow a pin 3/16 inch (5 mm) smaller than the nominal size of the punched holes to be inserted in the above manner.

Do not plug located holes without written approval from the Office of Materials Management.

Provide steel templates with hardened bushings in holes that are accurately located in relation to the centerline of the connection as inscribed on the template. The fabricator is not required to use hardened bushings when using a roto-broach, shell drill, or other similar tool, to make the holes.

Ream and drill holes through multiple piles only if the plies of the joint are held tightly together with bolts or clamps and if sub-punched or sub-drilled, only if the joint is pinned. Disassemble and clean the piles of burrs and shavings before final assembly.

The Fabricator shall drill holes full sized in unassembled pieces or connections, including templates for use with matching sub-sized and reamed holes, using suitable numerically controlled (N/C) drilling equipment. If using N/C drilling

equipment, demonstrate the accuracy of the drilling procedure to the inspector according to 513.24.

After holes are reamed or drilled full size, 85 percent of the holes in any contiguous groups shall have no offset greater than 1/32 inch (0.8 mm) between adjacent plies. The remainder of the holes shall not be offset more than 1/16 inch (1.6 mm) between adjacent plies.

If requested in writing, the Office of Materials Management may consider other methods of preparing holes for high-strength bolts.

513.20 High-Strength Steel Bolts, Nuts, and Washers. Provide high-strength steel bolts, nuts, and washers conforming for all bolted connections including erection bolts for cross frames and lateral bracing to 711.09.

A. General. Provide the Engineer with access to the work for observing the installation and the tightening and checking of the bolts.

Determine the required bolt length by adding the value from Table 513.20-1 to the grip. The table values include an allowance for manufacturing tolerances and provide a bolt length for threads to protrude through the nut. Add 5/32 inch (4 mm) for each hardened flat washer used and 5/16 inch (8 mm) for each beveled washer used. Adjust the length, as determined by Table 513.20-1, to the next longer 1/4 inch (6 mm); when installed, the end of the bolt shall be flush with or project several thread lengths outside the face of the nut.

TABLE 513.20-1

Bolt Size (inches)	To determine required bolt length, add to grip[1] (inches)
1/2	11/16
5/8	7/8
3/4	1
7/8	1 1/8
1	1 1/4
1 1/8	1 1/2
1 1/4	1 5/8
1 3/8	1 3/4
1 1/2	1 7/8

[1] Total thickness of all connected material excluding washers.

TABLE 513.20-1M

Bolt Size (mm)	To determine required bolt length, add to grip[1] (mm)
M16	24
M20	28
M22	31
M24	35
M27	38
M30	41
M36	47

[1] Total thickness of all connected material excluding washers.

Use bolts, nuts, and washers with a residual coating of lubricant when received. Bolts, nuts, and washers without their original lubrication shall not be used.

B. Preparation. With the exception of metalizing, galvanizing, and both organic zinc and inorganic zinc primers, remove coatings from joint surfaces, including surfaces adjacent to the bolt heads, nuts, and washers. Remove lacquer, dirt, oil, loose scale, rust, burrs, pits, and other substances or defects that prevent solid seating of the parts or interfere with the development of complete frictional contact. Do not place gaskets or other yielding material between joint surfaces.

C. Installation. For each bolt, place a hardened washer under the element (nut or bolt head) turned in tightening. If an outer face of the bolted parts has a slope of more than 1:20 with respect to a plane normal to the bolt axis, use a smooth beveled washer to compensate for the lack of parallelism.

If necessary, the Contractor may clip washers, at one location, not closer than seven-eighths of the bolt diameter from the center of the washer.

During final assembly of the parts to be bolted, first install a sufficient number of drift pins to provide and maintain accurate alignment of holes and parts, then a sufficient number of bolts tightened to a snug tight condition to bring all the parts of the joint into complete contact. Replace any bolts that were installed before installing drift pins. Before releasing the member from the hoisting equipment, fill half the holes with drift pins and bolts tightened to a snug tight condition in at least 50 percent of the holes (preferably, half pins and half bolts) but use at least two drift pines in each flange and web of each beam or girder. Install bolts starting at the most rigidly fixed or stiffest point and progress toward the free edges.

Use cylindrical drift pines that are not more than 1/32 inch (0.8 mm) smaller than the hole diameter.

Bolts are snug tight when an impact wrench begins to impact the nut or when a man applies full effort using an ordinary spud wrench.

Install bolts in the remaining open holes and tighten the bolts to a snug tight fit, after which all bolts shall be tightened completely by the turn-of-nut method or according to Supplement 1082.

Where difficulty is experienced with the fit of the connection and the bolts are used to draw the elements into contact, check all bolts in the affected portion of the connection for a sustained snug tight condition.

Replace drift pins with completely tightened bolts only after all the remaining holes are filled with completely tightened bolts.

Do not field ream holes drilled full size during fabrication.

After bolts are snug tight, the wrench operator shall match-mark the outer face of the nut with the flush or protruding portion of the bolt using a crayon or paint. The Engineer will use the match-marks to determine the relative rotation between the bolt and nut during final tightening using the turn-of-the-nut method.

Commence tightening at the most rigidly fixed or stiffest point and progress toward the free edges, both in the initial snugging up and in the final tightening. If

required because of wrench operation clearances, tightening may be done by turning the bolt. If used, provide impact wrenches of adequate capacity to perform the required tightening each bolt in approximately 10 seconds.

Do not reuse galvanized A 325 bolts. Re-tightening previously tightened bolts that became loose by tightening adjacent bolts is not reuse.

Follow the additional bolting requirements in 513.26.

D. Bolt Tension. When all bolts in the joint are tight, the minimum bolt tension for each bolt size is shown in Table 513.20-2.

TABLE 513.20-2

Bolt Size (inches)	Bolt Tension[1] (kips), minimum A 325
1/2	12
5/8	19
3/4	28
7/8	39
1	51
1 1/8	64
1 1/4	81
1 3/8	97
1 1/2	118

[1] Equal to 70 percent of specified minimum tensile strengths of bolts, rounded off to the nearest kip.

TABLE 513.20-3 NUT ROTATION FROM SNUG TIGHT CONDITION

Bolt Length (as measured from underside of head to extreme end of point)	Disposition of Outer Faces of Bolted Parts		
	Both faces normal to bolt axis	One face normal to bolt axis and other face sloped not more than 1:20 (bevel washer not used)	Both faces sloped not more than 1:20 from normal to bolt axis (bevel washer not used)
Up to and including 4 diameters	1/3 turn	1/2 turn	2/3 turn
Over 4 diameters but not exceeding 8 diameters	1/2 turn	2/3 turn	5/6 turn
Over 8 diameters but not exceeding 12 diameters	2/3 turn	5/6 turn	1 turn

Attain the bolt tension specified in Table 513.20-2 by tightening all bolts, the applicable amount of nut rotation specified in Table 513.20-3 by the turn-of-nut method.

Nut rotation is relative to bolt, regardless of the element (nut or bolt) being turned. Tighten bolts requiring 1/2 turn and less within ±30 degrees and tighten bolts requiring 2/3 turn and more within ±45 degrees.

E. Inspection.

1. The Engineer will inspect the first completed connection of each bridge according to 513.20.E.2 below and subsequent connections the Engineer deems

necessary. Thereafter, where the Engineer has approved the joint compactness and snug-tight condition of bolts prior to bolt tightening by the turn-of-nut method, the bolt tension as required in Table 513.20-2 shall be considered as attained if the amount of nut rotation specified by Table 513.20-3 is verified by the required match-marking.

2. Furnish and use manual torque wrenches to inspect bolts. Perform test to the satisfaction of the Engineer. Calibrate the inspection torque wrenches at least once each workday using a device, approved by the Engineer, and capable of indicating bolt tension. Use three bolts, placed and tensioned individually, representative of the grade, size, length, and condition used in the structure to determine the job inspection torque according to 513.20.E.3. Place a washer under the part being turned.

3. Tighten each of the three representative bolts, using any convenient manner, to the tension shown in Table 513.20-2. Then, using the inspection wrench, apply a slow steady pull to the tightened bolt and measure the torque required to turn the nut or head 5 degrees, approximately 1 inch (25 mm) at a 12-inch (300 mm) radius in the tightening direction. Use the average torque measured in the tensioning of the three bolts as the job inspection torque.

4. With the Engineer present, randomly select for inspection two bolts or 10 percent of the bolts, whichever is greater, from each connection represented by the 3-bolt sample described in 513.20.E.2. Using the inspection wrench, apply the job inspection torque in the tightening direction. The Engineer will accept the connection if the job inspection torque does not turn the nut or bolt head. If the job inspection torque turns a nut or bolt head, apply the job inspection torque to all the bolts in the connection and reinspect the connection as described above.

F. Calibration Devices. The manufacturer of the calibration device or a qualified testing laboratory shall periodically examine each calibration device at least once each year and other times if requested by the Engineer. After calibration, the manufacturer or testing laboratory shall certify that each calibration device accurately indicates the actual bolt tension.

513.21 Welding. Perform welding by the shielded metal-arc, submerged arc, flux cored arc, or stud welding process. Only shielded metal arc (stick) welding is prequalified. All other welding processes require testing and approval by the Office of Materials Management. Consideration will be given to other methods of metal-arc welding if a written request is submitted to the Office of Materials Management.

In other respects, the AASHTO/AWS *Bridge Welding Code*, as amended by Supplement 1011, shall govern the work.

Post copies of the shop welding procedures at each welding location.

Weld only fracture critical and main members when the fabrication quality control specialist and inspectors are physically at the facility. The fabricator shall not perform fracture critical welding without prior scheduling with the fabrication quality control specialist and the inspector. The fabrication quality control specialist shall witness the minimum percentages specified in Supplement 1078 and shall check all welding processes.

For non-fracture critical welds, the fabrication quality control specialist shall perform frequent inspections, and check all welding processes.

513.22 Stud Shear Connectors. Perform stud welding according to the AASHTO/AWS Bridge Welding Code, as amended by Supplement 1011, and this subsection.

In addition to the stud bend tests of Article 7.6.6.1 of the AASHTO/AWS Bridge Welding Code, perform bend tests of stud shear connectors at the start of each workday, when welding has been interrupted for an hour or more, when changing grounds, when changing weld settings, and when changing cable loop due to arc blow. Do not weld more than 500 studs without the welds being field bend tested in accordance with the specified procedure. The Contractor may leave in the bent position tested studs that show no sign of failure, as determined by the Engineer.

Weld stud shear connectors to the top flanges of beams or girders after the steel has been erected and suitable scaffolding or deck forming has been provided. Studs may be welded to beam or girder webs, end dams, bearing plates, or to other secondary members and detail material in the shop. For galvanized structures with welded shear connectors, remove the galvanic coating by grinding at each connector prior to welding.

513.23 Threads for Bolts and Pins. Threads for pins shall conform to the Unified Standard Series ANSI B1.1-UNC (ANSI B1.13M) Class 2A (6g) for external threads and Class 2B (6H) for internal threads, except that pin ends having a diameter of 1 3/8 inches (35 mm) or more shall be threaded 6 threads to the inch (4.23 mm/thread).

513.24 Shop Assembly. Remove paint, grease, oil, rust, loose mill scale, and protruding edges or burrs from all contact surfaces. Unless waived by the Office of Materials Management, do not assemble and weld flanges and webs to form girders or other similar members and do not accomplish fabrication or assembly that interferes with the repair of a butt weld until the fabrication quality control specialist for the A rated fabricators or the inspector for B and C rated fabricators examines and approves radiographs of all butt welds in the component parts.

Perform fit-up work with the members assembled in unloaded positions as shown on the shop drawing layout required by 513.06. During shop assembly, adequately support members, especially at joints, to prevent misalignment or deflection and designate supports that prevent settlement during the fit-up, reaming or drilling of connections. The fabrication quality control specialist shall maintain records of the actual horizontal and vertical dimensions and relative positions of each assembly for each offset required by 513.06 and, upon request, furnish a copy to the inspector. Reposition members that become a part of two assemblies for the second assembly to the dimensions recorded for the first assembly.

Using steel stamps, match-mark all connecting parts assembled in the shop for the purpose of reaming or drilling of holes for field connections or for fit-up of field welded connections before disassembly. Punch mark bearing centerlines.

Continuous beam and plate girders, including sections adjacent to hinged, pin connected, sliding, or rocker bearing joints, shall have at least three adjacent

segments assembled, and holes reamed or drilled while assembled. Check the fit-up of field welded connections by similar shop assembly.

Shop assemble longitudinal or transverse beams and girders that are either framed or connected by diaphragms and floor beams to check fit-up of connections to be field welded, or to ream or drill holes for bolted connections. Assemble trusses in lengths of at least three abutting panels before drilling or reaming field connections.

Include deck plates in the final shop assembly of bridges that involve railroad deck plates, even if welding of these deck plates takes place in the field.

If the fabricator elects to use numerically controlled drilling or punching, the required assembly shall be performed as specified above. The Office of Materials Management will consider the Contractor's written request to use other methods of checking hole alignment and match marking. If the Office of Materials Management does not consider, or disapproves the fabricator's proposed methods of assembly, perform the work according to 513.19 and 513.24.

After fabrication, shop assemble deck expansion devices to check fit-up, straightness, and roadway cross-slope changes. Full width assembly is required with phased construction if expansion devices have interlocking fingers or have mechanical devices that require exact field alignment. The maximum sweep at any point along all members of an expansion joint shall not exceed ¼" in 50'.

The fabricator may fabricate part-width deck segments without the required shop assembly under the following conditions:

A. The plans require a phased construction sequence.

B. Shop drawings incorporate a lay down, similar to 513.06, defining vertical offset dimensions from a full length common baseline to all roadway changes including sidewalks, rounding, crowns, and field splice points of the expansion device.

Secure parts not completely assembled in the shop with temporary bolts to prevent damage in handling and shipping. In the shop, bolt field splice plates into final position shift the splice plates laterally with respect to their final position so that the ends of the plates are flush with the ends of the member. Without the Office of Materials Management's written acceptance, do not weld or tack-weld to bolted assemblies. Perform authorized welding according to 513.21.

513.25 Nondestructive Testing. Nondestructive testing shall conform to the AASHTO/AWS *Bridge Welding Code*, as amended by Supplement 1011 and as specified below.

As the Engineer directs, perform ultrasonic or radiographic inspection of field welded repairs in main members for thick scabs, deep kerfs or nicks, and similar gross flaws. Ensure that all examined welds and base metal adjacent to a welded joint conform to the quality requirements specified in 513.21. Submit radiographs, field sketches showing specific locations, lengths and depths of the repair, and two copies of the radiographic or ultrasonic technical reports to the Office of Materials Management for acceptance. Receive the Office of Materials Management's

acceptance before performing construction activities making welds inaccessible for repair.

The Contractor or fabricator shall notify the Department at least 48 hours before performing nondestructive testing. Provide this notice even if specific hold or witness point inspections are not required by Supplement 1078.

The Office of Materials Management has the final authority to accept welds and will resolve controversies regarding the interpretation of radiographs, magnetic particle indications, or the acceptability of welds.

A. Radiographic Inspection of Welds. Before inspection, grind welds smooth. Grind web splices only where radiographed, except grind outside fascia surfaces the full length. Inspect the following welds:

1. The full length of all butt welds in flange material of plate girders or rolled beams. One hundred percent of butt welds in back up bars that remain in the structure.

2. The top and bottom one-third of transverse web splices in plate girders or rolled beams and show any cope holes. If an unacceptable weld occurs, radiograph an adjoining 12-inch (300 mm) length of weld not previously inspected. If unacceptable flaws are found in this adjoining segment, radiograph the remainder of the weld.

3. Butt welds in longitudinal stiffeners attached to tension areas of webs.

4. Twenty-five percent of each longitudinal web splice as selected by the inspector.

5. Full length of field flange cut repairs.

6. Other welds specified in the Contract or AASHTO/AWS *Bridge Welding Code*.

Use a steel stamp to make the radiograph identification mark shown on the shop drawing layout in the area marked "Weld Identification" of Figures 6.1A through 6.1D of the AASHTO/AWS *Bridge Welding Code* in a manner to make it visible in the radiograph of the area without resorting to superimposed like markings. Place steel stamped identification marks on flange plates so that after girder assembly the marks are on the inside of flange and outside the area fastened to the web. Identify films of repaired welds by the letter "R". Do not place steel stamped identification numbers within the weld area. Use superimposed characters to make other required markings.

Use film locations or a technique employed that will show the top and bottom images of the plate edge. Use films 4 1/2 × 17 inches (114 × 432 mm) where practical and a minimum film size of 4 1/2 × 10 inches (114 × 254 mm).

Supply a technical report for the RT testing similar to Annex III Form III-5 of the AASHTO/AWS *Bridge Welding Code*, and include the following: Project identification, member piece mark, description of the repairs made, and the qualification level of the technician.

The Department will take ownership of contact films. For main material repairs, provide sketches that clearly show specific locations, lengths and depths of field cuts, or damages repaired by field welding.

B. Magnetic Particle Inspection of Welds. Before magnetic particle inspection (MPI), complete welding required to fabricate each beam or girder, correct all visual defects, and clean the weld. If the fabricator's quality control plan is acceptable to the Department and additional processing does not produce a potential for cracking, the Department may allow the Contractor to perform MPI before complete welding.

Inspect welds using the procedure and techniques for the dry powder magnetic-particle examination of welds using the prod or the yoke method according to AWS 6.7.6. The prod test equipment shall have a functioning ammeter. Provide a prod magnetizing current of 100 amperes per inch (25 mm) of prod spacing but not less than 400 amperes. Use only aluminum prods.

Inspect at least 1 foot (0.3 m) for every 10 feet (3 m), or fraction thereof, for each size of weld in the following:

1. Flange-to-web welds, including ends of girder after trimming.
2. Moment plate to flange welds.
3. Bearing stiffener welds.
4. Other welds specified in the Contract or AASHTO/AWS *Bridge Welding Code*.
5. Field weld repairs as directed by the Engineer.

The inspector or the fabrication quality control specialist will select random test sections. Unless waived by the Office of Materials Management, the inspector will observe inspection by C-rated fabricators. Position test sections as necessary for the inspection and after considering the safety and convenience to the inspecting personnel.

If a test section contains unacceptable defects, test 5-foot (1.5 m) segments on both sides of the test section, or, if less than 5-foot (1.5 m) segments are on both sides of the test section, test the full length of the weld. Retest welds requiring repair after repairs are complete.

MPI will not locate all surface defects of Article 9.21 of the AASHTO/AWS *Bridge Welding Code*. Unacceptable welds have MPI results that indicate defects exceed the above quality standards.

For each unacceptable defect, the fabricator shall record the piece mark, the location of the defect on the member, the defect description, and the proposed repairs.

C. Ultrasonic Testing of Welds. Perform ultrasonic inspection of the following welds:

1. Complete joint penetration flange-to-web, T, or corner joint welds: 25 percent for non-FCM, 25 percent compression or shear FCM, and 100 percent tension FCM.

2. Complete penetration butt welds: 100 percent tension FCM and 25 percent compression FCM.

3. Other welds: as specified in the Contract or AASHTO/AWS *Bridge Welding Code*.

The fabrication quality control specialist shall provide the Engineer with specified certification, sketches, technician reports, and a letter documenting that the Contractor performed nondestructive testing according to this specification.

513.26 Shipping, Storage, and Erection. Repair or replace, at the discretion of the Office of Materials Management, members damaged by improper handling, storing, or erection.

During transportation, place adequate blocking between members to prevent movement and facilitate unloading. Unless reinforced by additional plates, angles, or other material bolted in place, do not use field connection holes for tie-down. Band together bearing components.

Place material stored in the fabricating shop or in the field on skids or blocks to prevent the metal from contacting the ground. Place and shore girders and beams in an upright position for shipping, and field and shop storage. Field splice plates shall be bolted with temporary bolts, which shall be removed and replaced, when field splice plated are placed in their final position or shifted laterally with respect to their final position. Keep material clean and properly drained. Install bearing devices and anchorages according to Item 516.

Thoroughly clean bearing surfaces and surfaces to be in permanent contact before the members are assembled in the field.

Before erecting structural steel, completely bolt up field splices and connections that started before steel erection.

During erection, the Engineer will allow drifting to draw the parts into position, but do not enlarge the holes or distort the metal. Install drift pins and bolts according to 513.20. Fill at least three-fourths of the holes with completely tightened bolts in splices and connections subject to construction loads during erection. Complete permanent fastening of steel truss tension chord members before removing falsework. Permanently fasten compression chord members after the span is released sufficiently from the falsework to bring the compression chord joints into full bearing. Properly regulate and maintain elevations of panel points and ends of floor beams until the falsework is removed.

Do not enlarge the holes of splices and connections between segments or elements of main members without approval by the Office of Materials Management.

Adjust structures to the correct alignment and to the marked bearing centerlines before beginning permanent fastening. Do not permanently fasten cross frames and lateral bracing in continuous beam or girder spans until completing main connections in adjacent spans; however, install sufficient bracing to maintain structural stability. For erection bolts used to fasten cross frames, use not less than 5/8-inch (16 mm) diameter, and fully tighten bolts according to 513.20.

Erect end cross frames and end dams in a manner that ensures bearing parts remain in bearing contact.

Permanently fasten all intermediate cross frames before deck placement begins.

The webs of primary members shall be plumb before deck placement begins.

513.27 Shop Coating. For steel surfaces specified to be coated according to Item 514, apply a prime coat in the shop.

513.28 Cleaning ASTM A 709/A 709M, Grade 50W (345W) Steel. Before the new steel is shipped, solvent clean, where necessary, all surfaces of ASTM A 709/A 709M, and Grade 50W (345W) steel that are to be left unpainted to remove all traces of asphalt cement, oil, grease, diesel fuel deposits, chalk, paint marks, and other soluble contaminants according to SSPC-SP 1 Solvent Cleaning. QCP #1 and QCP #2 shall apply according to Item 514.

Shop blast unpainted Grade 50W material and main members requiring galvanized coating to SSPC-SP 6, commercial blast. QCP #3 shall apply according to Item 514.

After placing superstructure concrete, clean, where necessary, the exterior surface and bottom flanges of all fascia beams or girders that are to be left unpainted to remove all traces of asphalt cement, oil, grease, diesel fuel or petroleum deposits, concrete, and other contaminants.

Do not use acid for cleaning.

513.29 Method of Measurement. The Department will measure Structural Steel Members on a lump sum basis or by the number of pounds (kilograms).

If payment is per pound (kilograms), submit weight computations to the Office of Materials Management based upon the accepted shop drawings. Deduct waste material, removed by burning, cutting, machining, holes, etc., but include groove weld bevels. Include the weight of all permanent fasteners, shop fillet welds, other metals and preformed bearing pads. Exclude the weight of paint or galvanized coatings. Exclude thickness or weight of members exceeding the plan requirements (due to overweight or other cause), unless authorized by the Department. As an option, measure and record the weight of structural members before painting in the presence of the inspector. Use the following unit weights for computations.

	lb/ft³	**(kg/m³)**
Steel, cast steel, and deposited weld metal	490	(7850)
Cast iron	450	(7210)
Phosphor or leaded bronze	550	(8810)
Lead	710	(11370)
Preformed bearing pads	710	(11370)

The Department will measure Welded Stud Shear Connectors by the number of each installed and accepted.

513.30 Basis of Payment. If the fabricator's proposed methods of assembly with numerically controlled drilling or punching fail to produce specified results and the Office of Materials Management directs the Contractor to perform work, as according to 513.19 and 513.24, the Department will not pay for this work.

For steel surfaces specified to be coated according to Item 514, the cost of applying a prime coat in the shop is incidental to the bid for structural steel.

The Department will not pay for repairing or replacing members damaged by improper handling, storing, transportation, or erection.

The Department will pay for the accepted quantities at the contract prices as follows:

Item	Unit	Description
513	Lump Sum	Structural Steel Members, Level UF
513	Lump Sum	Structural Steel Members, Level 1
513	Lump Sum	Structural Steel Members, Level 2
513	Lump Sum	Structural Steel Members, Level 3
513	Lump Sum	Structural Steel Members, Level 4
513	Lump Sum	Structural Steel Members, Level 5
513	Lump Sum	Structural Steel Members, Level 6
513	Pound (Kilogram)	Structural Steel Members, Level UF
513	Pound (Kilogram)	Structural Steel Members, Level 1
513	Pound (Kilogram)	Structural Steel Members, Level 2
513	Pound (Kilogram)	Structural Steel Members, Level 3
513	Pound (Kilogram)	Structural Steel Members, Level 4
513	Pound (Kilogram)	Structural Steel Members, Level 5
513	Pound (Kilogram)	Structural Steel Members, Level 6
513	Each	Welded Stud Shear Connectors

ITEM 514 PAINTING OF STRUCTURAL STEEL

514.01 Description. This work consists of cleaning and painting all steel surfaces.

514.02 Materials. On existing steel, apply a three-coat paint system consisting of an organic zinc prime coat, an epoxy intermediate coat, and a urethane finish coat. The coating system shall conform to 708.02.

On new steel, apply a three-coat paint system consisting of an inorganic zinc prime coat, an epoxy intermediate coat, and a urethane finish coat. The prime coat shall conform to 708.01, and the intermediate and finish coats shall conform to 708.02. Supply the intermediate and finish coats from the same manufacturer. The Contractor is responsible for ensuring the compatibility of the intermediate and finish coats with the prime coat.

For caulking, use a single pack moisture cured polyurethane based material, which will not shrink, or sag capable of filling voids up to 1 inch (25 mm) wide. Only material that is listed on the OMM Qualified Product List website may be used.

514.03 Superintendent. In addition to the requirements of 105.06, the Superintendent must successfully complete a Bridge Painting pre-qualification course and training offered by the Department. The course must have been completed within the past four years and an individual course certificate must have been received by the Superintendent. Present certificate to the Engineer prior to commencing work. No work is permitted unless the Superintendent provides a valid course certificate.

514.04 Quality Control. Quality control consists of designating quality control specialists to control the quality of work in each phase established by Quality Control Points (QCPs). Control quality by inspection, tests, and cooperation with inspection and testing performed by the Engineer and inspector.

A. Quality Control Specialist. Identify the individuals dedicated to performing duties as the painting quality control specialists before starting work in the field. Provide a quality control specialist for each structure, but one quality control specialist must be provided for every three structures for which work is progressing concurrently on this contract.

Each quality control specialist must have a current certification from one of the following:

1. NACE (National Association of Corrosion Engineers) coating inspector Level 1

2. SSPC (The Society for Protective Coatings) protective coating specialist

3. SSPC protective coating inspector Level 1, SSPC bridge coating inspector Level 1

4. AMPP (Association for Materials Protection and Performance) Coating Inspector Level 1

5. AMPP Bridge Coating Inspector Level 1

6. Individuals trained prior to 7-15-22 by NACE or SSPC certified coating or inspector Level 1 or higher will be accepted for 5 years from the date on their certificate after their training per the old specification.

The quality control specialist must successfully complete a Bridge Painting prequalification course offered by the Department. The training course must have been completed within the past four years and an individual course transcript must have been received by the quality control specialist.

Provide the following to the Office of Construction Administration to be placed on the approved Quality Control Specialist List.

1. Copy of your current AMPP, NACE or SSPC certification. Applications for individuals trained prior to 7-15-22 by a NACE or SSPC certified individual will be accepted until 5 years after their training.

2. Transcript from your Bridge Painting Prequalification Course (Work Type 26 Course).

3. Application with photo included from the Office of Construction Administration Website.

Select only a quality control specialist who is approved by the Department. The Office of Construction Administration will publish a list of approved Quality Control Specialists. Present all required certificates, letters of certification, and valid identification to the Engineer prior to commencing work.

The quality control specialist will be immediately removed from their duties as the quality control specialist and disqualified from future duties as the quality control specialist if any quality control failure occurs. A quality control failure is defined as any of the following:

1. The dry film thickness has been approved by the quality control specialist and it is later found that over 20 percent of the spot measurements of any one member of a structure, such as a cross frame, web, flange, stiffener, or other parts of the structure are either under the minimum or over the maximum spot thickness.

2. The dry film thickness has been approved by the quality control specialist and it is later found that the thicknesses of any area of a structure as described in 514.20 are either under the minimum or over the maximum specification thickness.

3. Two separate occurrences when the surface preparation has been approved by the quality control specialist of any one member type, such as the cross frames, webs, flanges, stiffeners, or other parts of the structure and it is later found that the surfaces of those members were either not properly profiled or not properly cleaned as required by the Contract Documents. Occurrences are determined per structure.

4. Two separate occurrences of the quality control specialist performing production duties not allowed by the Contract Documents. Occurrences are determined per structure.

5. Two separate occurrences when the quality control specialist fails to perform any one of the duties assigned to the quality control specialist in the Contract Documents. Occurrences are determined per structure.

Suspend work if the quality control specialist is not available or has been removed. The Engineer or Inspector will immediately provide written notification to the Office of Construction Administration of any quality control failure identified above. Resume work when a quality control specialist, qualified and approved as provided in 514.04, is available.

For work in the fabrication shop, each fabricator shall identify one or more full-time individuals who shall perform the duties of the painting quality control specialist.

The quality control specialist may not be used to perform production duties including supervision, blasting, painting, waste disposal, mixing, operating or repairing equipment, or other tasks not associated with duties of the quality control specialist while the Contractor is performing work toward the completion of a Quality Control Point.

Ensure that each quality control specialist is trained and equipped with Safety Data Sheets (SDS), product data sheets, tools, and equipment necessary to provide quality control on all aspects of the work. Each quality control specialist shall have a thorough understanding of the plans for the work, including any pertinent addenda, change order, or other contract documents, and these Specifications. Duties each quality control specialist shall perform include:

1. Inspect equipment and abrasive at specified intervals.

2. Approve the work and provide documentation that the work has been approved immediately before each QCP.

3. Inspect the work with the Engineer or Inspector at each QCP.

4. Verify the Contractor or fabricator performed work according to the Contract Documents.

5. Cooperate with the inspection and testing performed by the Engineer and inspector.

6. Document test results and compare test results with the Engineer's and inspector's test results.

7. Notify Superintendent of nonconforming work.

8. Stop work when test equipment is not available and when necessary to ensure the work is performed according to the Contract.

The fabricator's quality control specialists shall provide the Engineer with a letter that includes specified information or check point data documenting acceptance of the work and consisting of the following:

1. Checks on the abrasive to ensure that it has not been contaminated with oil.

2. The profile of the blasted surface.

3. The air and steel temperature and dew point before blast cleaning and painting and at 4-hour intervals during the blasting and painting operation.

4. Readings of the actual dry film thickness.

5. The lot and stock number of the paint and the date of manufacture.

6. Documentation that the paint mixer is functioning properly, that each spray operator has demonstrated the ability to paint, and that all spray equipment is used according to the manufacturer's recommendation.

B. Quality Control Points (QCP). QCPs are points in time when one phase of the work is complete and approved by the quality control specialist and ready for inspection by the Engineer or the inspector before commencing the next phase of the work. At a QCP, the quality control specialist shall provide quality control tests bearing his signature to the Engineer or Inspector. The Contractor or fabricator shall provide the Engineer and inspectors access to inspect all affected surfaces. If inspection identifies a deficiency, correct the deficiency according to the Contract Documents before starting the next phase of work. Discovery of defective work or material after a Quality Control Point is past or failure of the final product before final acceptance, shall not, in any way, prevent the Department from rejecting the final product or obligate the Department to final acceptance. **Final acceptance will be determined according to 514.21, Final Inspection.**

Quality Control Points	Purpose	New Steel	Existing Steel
1. Solvent Cleaning	Remove asphalt cement, oil, grease, etc.	Yes	Yes
2. Grinding Flange Edges	Remove sharp corners	Yes	Yes
3. Abrasive Blasting	Blast surfaces to receive paint	Yes	Yes
4. Containment/ Waste Disposal	Contain, collect, & dispose of abrasive blasting debris	No	Yes
5. Prime Coat Application	Check surface cleanliness, apply prime coat, check coating thickness	Yes	Yes
6. Remove Fins, Tears, & Slivers	Remove surface defects and slivers	Yes	Yes
7. Washing of Shop Primer	Remove all water soluble materials (salt, dirt, etc.)	Yes	No
8. Intermediate Coat Application	Check surface cleanliness, apply intermediate coat, check coating thickness	Yes	Yes
9. Caulking	Caulk areas not sealed by the intermediate coat	Yes	Yes
10. Finish Coat Application	Check surface cleanliness, apply finish coat, check coating thickness	Yes	Yes
11. Final Review	Acceptance and check total system thickness	Yes	Yes

Provide signed documentation of inspection, testing, conditions and material information to the Engineer on the following ODOT forms, or forms with the equivalent information.

QCS	Inspection Documentation Sign Off for QCP's	CA-S-7
QCP#1	Solvent Cleaning	CA-S-12
QCP#2	Grinding Flange Edges	CA-S-12
QCP#3	Abrasive Blasting	CA-S-13
QCP#3	QCS & Visual Standards Information for Abrasive Blasting Test Section	CA-S-11
QCP#4	Disposal of Hazardous/Non-Hazardous Waste	CA-S-14
QCP#5	Prime Coat Application	CA-S-15
QCP#5	Dry Film Thickness Readings for Prime Coats	CA-S-2
QCP#6	Grinding Fins, Tears and Slivers	CA-S-16
QCP#8	Dry Film Thickness Readings for Intermediate Coats	CA-S-2
QCP#9	Caulking	CA-S-16
QCP#8	Intermediate Coat Application	CA-S-17
QCP#10	Finish Coat Application	CA-S-17
QCP#10	Dry Film Thickness Readings for Finish Coats	CA-S-2

514.05 Testing Equipment. For the project duration, provide the Engineer or inspectors with the test equipment listed below for the type of work at each work site with ongoing work. With the exception of the recording thermometer, the fabricator shall provide its quality control specialists with the test equipment listed below. The Contractor and fabricator shall maintain all testing equipment in good working order, and provide documentation or certification of calibration from the manufacturer. If the Contractor or Fabricator and the Engineer's inspector are using different test equipment, the Contractor or Fabricator and the Engineer's inspector will perform side-by-side testing and compare results. If the difference between the Department's and Contractor's or Fabricator's tests results, such as blast profile, dry film thickness, temperature, dew point and relative humidity, are greater than 1%, the Contractor or Fabricator and the Engineer will determine the reason for the differences and make necessary adjustments.

A. Provide a digital camera with the following features:

1. 5.0 Megapixel or greater resolution.
2. Minimum 3× Optical zoom lens capability with automatic focus.
3. Minimum 512MB Memory capability.
4. Built-in flash.

B. One Spring micrometer and extra-coarse replica tape or comparable electronic surface profile gauge for the measurement of abrasive blast profile depth within ±0.2 mils on the project at all times.

C. One SSPC-PA2 Type 2 (electronic) non-destructive coating thickness gage, with a set of calibration thickness foils, (shims), and two sets of National Institute

of Standards & Technology calibration plates. The first set of calibration plates shall be 1.5 to 8 mils (38 to 200 µm), Model No. 1362b, and the second set shall be 10 to 25 mils (250 to 625 µm), Model No. 1363b. Other certified coating thickness standard plates for ferrous substrates must be approved for use by the Office of Construction Administration.

D. One Sling Psychrometer including Psychrometric tables, (or comparable electronic or digital equipment for the measurement of dew point, accurate within 2 °F (1 °C) and within one percent relative humidity).

E. Two steel surface thermometers accurate within 2 °F (1 °C).

F. Flashlight 2-D cell.

G. SSPC Visual Standard for Abrasive Blast Cleaned Steel (SSPC-VIS 1).

H. One recording thermometer capable of recording the date, time, and temperature over a period of at least 12 hours.

514.06 Work Limitations. Apply the prime coat to new structural steel inside permanent buildings at the fabricator's facility. If inside permanent buildings, the fabricator may perform year-round abrasive blasting and painting. Perform abrasive blasting and painting in the field from April 1 to October 31 unless otherwise approved by the Engineer. The Department will not issue a time extension due to adverse weather during the month of April. The plans or other Contract Documents may require additional work limitations for specific bridges or projects.

A. Temperature. Do not apply Inorganic Zinc Primer if the steel, air, and paint temperature is below 40 ºF (4 ºC). Do not apply Organic Zinc Primer, Epoxy Intermediate, or Urethane Finish Coats if the steel, air, and paint temperature is below 50 ºF (10 ºC). Follow the paint manufacturers printed instructions for the minimum times to handle, recoat and cure the individual coats for specified conditions and thicknesses.

Monitor and document that the temperatures listed below are maintained for minimum time frames listed below, after application of each coat, by using the recording thermometer. The Contractor may use a heated enclosure or building. Supply heat continuously and uniformly to maintain the required minimum temperature within the enclosure or building.

Minimum Times to maintain temp. per coating.	**50 °F (10 °C)**	**60 °F (16 °C)**	**70 °F (21 °C)**
Primer (Organic Zinc)	4 hrs	3 hrs	2 hrs
Intermediate (Epoxy)	6 hrs	5 hrs	4 hrs
Finish (Urethane)	8 hrs	6 hrs	4 hrs

If combustion type heating units are used, vent the units away from the enclosure or building and do not allow exhaust fumes to enter the enclosure or building. Do not use open combustion in the enclosure or building.

The fabricator may use radiant heat when painting new structural steel inside permanent shop buildings. Locate radiant heaters at least 10 feet (3 m) above all surfaces to be painted. Vent exhaust fumes to prevent fumes from contacting surfaces to be painted.

B. Moisture. Do not apply paint:

1. If the steel surface temperature is less than 5 °F (3 °C) above the dew point.

2. If the steel surface is wet, damp, frosted, or ice-coated.

3. If the relative humidity is greater than 85 percent.

4. During periods of rain, fog, or mist unless the above moisture criteria is met.

If steel was abrasive blasted when the temperature of the steel was less than 5 °F (3 °C) above the dew point, reblast the steel when the steel temperature is at least 5 °F (3 °C) above the dew point.

514.07 Protection of Persons and Property. Collect, remove, and dispose of all rubbish, buckets, rags, or other discarded materials and leave the job site in a clean condition.

Except for deck bottoms and backwalls which have not been sealed or are not to have a sealer applied, protect all portions of the structure, that are not to be painted from damage or disfigurement by splashes, spatters, and smirches of paint.

If the Contractor causes any damage or injury to public or private property, the Contractor shall restore the property, to a condition similar or equal to the condition existing before the damage or injury.

514.08 Pollution Control. Comply with pollution control laws, rules, or regulations of Federal, State, or local agencies and requirements of this specification.

514.09 Safety Requirements and Precautions. Comply with the applicable safety requirements of the Ohio Industrial Commission and OSHA.

Provide Safety Data Sheets (SDS) at the preconstruction meeting for all paints, thinners, and abrasives used on this project. Do not begin work until submitting the SDS to the Engineer.

514.10 Inspection Access and Lighting. In addition to the requirements of 105.10, furnish, erect, and move scaffolding and other appropriate equipment to allow the inspector and the Engineer the opportunity to closely observe all affected surfaces during all phases of the work and for at least 10 workdays after completely painting each structure to allow for the Final Inspection according to 514.21. Provide artificial lighting as necessary to supplement natural light with a minimum of 30 foot candles (325 LUX) at the surface of the steel for inspection, cleaning, and painting. Prevent glare that interferes with traffic, workers and inspection. Submit fully detailed Engineered Drawings of the scaffolding or work platforms used for inspection access to the Engineer at least 14 days before installation. All details of the inspection access shall comply with the applicable safety requirements of The Ohio Industrial Commission and OSHA. Provide details and locations of all connections, to the permanent structure, used for painting and inspection of the structure with the Engineered Drawings. Damage to the permanent structure shall be avoided. Do not drill into the bottom of the deck or under bearing locations or similar areas of concern for the structure. The details shall be reviewed, signed,

stamped and dated by an Ohio registered Professional Engineer certifying that they meet these requirements. The Engineer will provide a written response to the submittal in accordance with 105.02. Do not begin work until the Engineers acceptance has been received. Perform all work in accordance with the accepted Engineering Drawings. Immediately cease all operations that deviate from the accepted Engineered Drawings. If a deviation is necessary, prepare revised Engineering Drawings as noted above and furnish the Engineer a copy of revised Engineering Drawings. Do not begin work until the revised drawings are accepted by the Engineer. Maintain the in-place inspection access equipment employed during original painting activities or provide alternate inspection equipment such as platform lifts, bucket trucks, snooper trucks, or equivalent as approved by the Engineer. If scaffolding, or any hanger attached to the scaffolding, is supported by horizontal wire ropes, or if scaffolding is directly under the surface to be painted, comply with the following requirements:

A. If scaffolding is suspended 43 inches (1092 mm) or more below the surface to be painted, place two guardrails on all sides of the scaffolding. Place one guardrail at 42 inches (1067 mm) above the scaffolding and the other guardrail at 20 inches (508 mm) above the scaffolding.

B. If scaffolding is suspended at least 21 inches (533 mm) but less than 43 inches (1092 mm) below the surface to be painted, place one guardrail on all sides of the scaffolding at 20 inches (508 mm) above the scaffolding.

C. If 514.10.A and 514.10.B do not apply, place two guardrails on all sides of scaffolding. Place one guardrail at 42 inches (1067 mm) above the scaffolding and the other guardrail at 20 inches (508 mm) above scaffolding.

D. Provide scaffolding at least 24 inches (610 mm) wide if guardrail is used and 28 inches (711 mm) wide if guardrail is not used and scaffolding is suspended less than 21 inches (533 mm) below the surface to be painted. If using two or more parallel scaffolding to achieve the proper width, rigidly attach the scaffolding together to prevent differential movement.

E. Construct guardrail as a substantial barrier, securely fastened in place and free from protruding objects such as nails, screws, and bolts. Provide a properly located opening in the guardrail to allow the Engineer and inspector access onto the scaffolding.

F. Construct guardrails and uprights of metal pipe, steel angles, or wood. If using pipe railing, provide pipe with a nominal diameter of at least 1 1/2 inches (38 mm). If using steel angle railing, provide 2 × 2 × 3/8-inch (50 × 50 × 9 mm) steel angles or other metal shapes of equal or greater strength. If using wood railing, provide 2 × 4 inch (50 × 100 mm) nominal stock. Space uprights no more than 8 feet (2.4 m) on center. If using wood uprights, provide 2 × 4 inch (50 × 100 mm) nominal stock.

G. If the surface to be inspected is more than 15 feet (4.57 m) above the ground or water, and the scaffolding is supported from the structure being painted, provide a safety harness (not a safety belt) and lifeline for the Engineer and inspector. The lifeline shall not allow a fall greater than 6 feet (1.8 m). Provide a method to attach the lifeline to the structure that is independent of the scaffolding, cables, and brackets supporting the scaffolding.

H. If scaffolding is more than 2.5 feet (762 mm) above the ground, provide an access ladder and equipment to attach the ladder onto the scaffolding capable of supporting 250 pounds (113 kg) with a safety factor of at least four. uniformly space rungs, steps, cleats, and treads no more than 12 inches (305 mm) on center. Extend at least one side rail at least 36 inches (914 mm) above the landing near the top of the ladder.

I. If the distance from the ladder to the access point on the scaffolding exceeds 12 inches (305 mm), provide an additional landing that is capable of supporting a minimum of 1000 pounds (454 kg) and at least 24 inches (610 mm) wide and 24 inches (610 mm) long. Size and shape the landing so that the distance from the landing to the point where the scaffolding is accessed does not exceed 12 inches (305 mm). Firmly attach the landing to the ladder; however, do not use the ladder to support the landing.

J. In addition to the scaffolding requirements above, comply with all Federal, State, and local laws, ordinances, regulations, orders, and decrees.

K. Furnish all necessary traffic control to allow inspection during and after all phases of the project.

514.11 Job Site Visual Standards. Before starting abrasive blasting, establish job site visual standards by preparing a test section, subsequent test sections, and by using photographs of approved test sections. Use job site visual standards and SSPC-VIS 1 standard for blasting. The Contractor or fabricator shall prepare an approximately 20 to 30 square foot (2 to 3 m^2) test section from a representative area on the first structure to be painted. After the Engineer or Inspector and the Contractor or fabricator agree the test area was blast cleaned to the requirements of the Contract Documents, photograph the test section and check the steel surface for the proper profile. After the Engineer or Inspector approves the test section and the job site visual standards are documented by photographs and replica tape, the Contractor or fabricator may start abrasive blasting. The quality control specialists and Engineer or Inspector will use the job site visual standards (photographs), the Plan, Specification and requirements to determine acceptance of blast cleaning procedures. In all cases of dispute, the SSPC-VIS 1 standard shall govern. If the Contractor, Engineer, Inspector, or fabricator believe the initial test section does not establish the proper visual standard for a different structure another test section on the different structure may be performed.

514.12 Quality Control Point Photographic Verification and Documentation. The Engineer or Inspector will take a sufficient number of photographs to document the condition of the work at Quality Control Points 3, 4 and 11.

514.13 Surface Preparation.

A. Solvent Cleaning (QCP #1). Solvent clean by methods described in SSPC-SP 1, areas containing oil, grease, asphalt cement, diesel fuel deposits, other petroleum products and contaminants.

B. Grinding Flange Edges (QCP #2). Before abrasive blasting, round all exposed flange edges of all beams and girders to a radius of 1/8 ±1/16 inch (3 ±1.5

mm). This work has no weather and temperature restrictions. For shop painted steel, ground the sides of thermally cut material 1 ½ inch (40 mm) or thicker to remove the heat effected zone, as necessary, to achieve the specified surface cleaning.

C. Abrasive Blasting (QCP #3). Do not abrasive blast areas that contain asphalt cement, oil, grease, or diesel fuel deposits. Before abrasive blasting, completely remove all dirt, sand, bird nests, bird droppings, and other debris from the scuppers, bulb angles, and pier and abutment seats.

Abrasive blast all steel to be painted according to SSPC-SP 10 and as shown on the pictorial surface preparation standards for painting steel surfaces shown in SSPC-VIS 1. Maintain steel in a blast cleaned condition until it has received a prime coat of paint. The Contractor may commercial blast clean the back side of end cross frame assemblies that are 3 inches (75 mm) or closer to backwalls according to SSPC-SP 6.

Cover and protect galvanized and metalized steel (including corrugated steel bridge flooring), adjacent concrete already or specified to be coated or sealed, and other surfaces not intended to be painted, from damage caused by blasting and painting operations. Repair adjacent coatings damaged during the blasting operation. Backwalls and bottoms of decks not sealed nor specified to be sealed do not need to be covered and protected.

For field blasting use a recyclable steel grit, recyclable amorphous metal oxides or a recyclable natural mineral, low dusting abrasive. Recycled glass abrasives with no beryllium and no more than 0.5 percent free silica will be allowed on small areas with less than 1000 square feet of field blasting on a structure. Do not use silica sands, mineral slags, and other types of non-metallic abrasives that contain more than 0.5 percent free silica, by weight, have a chlorides salts content more than 25 ppm, and contain any organic material. For shop blasting use an abrasive that produces an angular profile. All abrasives shall provide a profile from 1.5 to 3.5 mils as determined by replica tape according to ASTM D 4417, Method C. Adjust the abrasive size, blast hose nozzle pressure or other means in order to provide the 1.5 to 3.5 mil profile. Clean the abrasive of paint chips, rust, mill scale, and other foreign material after each use and before each reuse. Use equipment specifically designed for cleaning the abrasive.

Check abrasives used at the job site or fabrication shop for oil contamination at the beginning of each shift and at 4-hour intervals. Also check each load of abrasive delivered to the job site or fabrication shop for oil contamination before use. Check for oil by placing a small sample of abrasives and tap water into a jar. Reject the abrasive if an oil film is detected on the water surface.

To ensure that the compressed air is not contaminated, the quality control specialists shall blow air from the nozzle for 30 seconds onto a white cloth or blotter held in a rigid frame. If the cloth or blotter retains oil or other contaminants, suspend abrasive blasting until retests verify the problem was corrected. Perform this test at the start of each shift and at 4-hour intervals.

The Contractor may simultaneously abrasive blast and paint the same bridge provided the abrasive blasting debris and dust does not contact freshly painted surfaces and does not contaminate paint during the curing period. For shop blasting,

the fabricator may simultaneously abrasive blast and paint if the two operations are separated by distance or containment that prevents paint contamination.

For surface preparation of new structural steel in the fabricator's shop, the quality control specialist shall take replica tape readings as follows:

1. For an automated blasting process, test the greater of 20 percent of the main members or one member per shift. These tests shall consist of taking five random readings per member.

2. For a manual blasting process, test each main member. The test of a main member consists of taking five readings at random locations.

3. For both an automated and manual blasting process, test 15 percent of all secondary members. The test of a secondary member consists of taking one random reading.

Remove abrasives and residue from all surfaces to be painted. Keep all structural steel that was blast cleaned in the field or the fabricator's shop dust free. Apply a prime coat to steel that was blast cleaned in the field within 12 hours of the beginning of the abrasive blasting operation. Apply a prime coat to structural steel that was blast cleaned in the fabricator's shop within 24 hours of the beginning of the abrasive blasting operation. If a prime coat is not applied within the times stated above, reblast the steel before applying the prime coat. Remove all dust or abrasives from adjacent work and from the finish coat.

Provide the Engineer and Inspector with field wash facilities and an adequate supply of running potable water, soap, and towels for washing face and hands during the surface preparation operation. Properly contain, test, and dispose of the wastewater. Locate a wash facility at each bridge site and in an area that will not be contaminated by the blasting debris.

D. Containment/Waste Disposal (QCP #4). Waste material generated by abrasive blasting operations in the field is a solid waste and may be a hazardous waste. Contain, collect, store, evaluate, and properly dispose of the waste material. Comply with all Federal, State, and local environmental protection laws, regulations, and ordinances including, but not limited to, air quality, waste containment, and waste removal. The Contractor is advised that various governmental bodies are involved with solid waste and hazardous waste disposal and the Contractor is responsible for complying with laws enforced by the various governmental bodies.

To prevent contamination of the pavement or soil, park all equipment on ground covers free of cuts, tears, and holes.

Clean equipment of spent abrasives or debris before bringing equipment to the project, moving equipment from one bridge site to another, and removing equipment from the project. Store debris cleaned from equipment with the debris from the structure that generated the debris.

Erect an enclosure to completely surround (around, under and over the top on truss type bridges) the blasting operations. The Contractor may use the ground as the bottom of the enclosure if the ground is completely covered with plastic or tarps.

Construct the enclosure of flexible materials such as tarpaulins (specifically designed for blasting containments), or construct the enclosure of rigid materials such as plywood. Maintain all materials free of tears, cuts, and holes. Overlap all seams a minimum of 6 inches (150 mm) and fasten the seams together at 12-inch (300 mm) centers or in a manner that ensures a seal that does not allow openings between the edges of the containment material. Extend the vertical sides of the enclosure completely up to the bottom of the deck on a steel beam bridge and use bulkheads between beams to enclose the blasting area.

Collect all debris from blasting operations, equipment, or filters, and all debris that fell to the ground. Store the debris in steel containers/drums with lids that are locked at the end of each workday. Store the debris in these locked drums while in the storage location and when hauled from the storage location to the disposal site. The storage location shall be at the bridge site unless, the Engineer and Contractor agree on an alternate storage location. Secure the storage location by surrounding the site with a 5 foot (1.5 m) high dumpster or a 5 foot (1.5 m) high chain link fence fabric supported by traffic sign drive posts 10 feet (3 m) apart. Drive the traffic signposts into the ground at least 2 feet (0.6 m) deep. Secure the dumpster or fencing with padlocks at the end of each day. The location of centralized cleaning stations for recyclable steel shall also be agreed by the Engineer and the Contractor.

Test and evaluate the debris for disposal. Obtain the services of a testing laboratory to obtain directly from the project site and evaluate a composite representative sample of the abrasive blasting debris for each bridge site. The person taking the sample must be an employee of the testing laboratory.

Take composite sample in the presence of the Engineer or Inspector, comply with the requirements of U.S. EPA Publication SW 846 and take individual samples from all containers that are on the site at the time of the sampling. Blend individual samples of equal size together to comprise one composite sample. Take one individual sample from each drum and four randomly spaced individual samples from each container other than drums.

Take individual samples and place into clean glass or plastic containers.

Prepare a chain of custody record (Chain of Custody) for all composite samples. The Chain of Custody must include the name of the person taking the sample, the name of the testing laboratory for which the person works, the date and time the sample was taken, the bridge sampled, the Township and Municipality where the bridge is located, and the signatures and dates of all persons in possession of the sample in the Chain of Custody.

Sample the abrasive blasting debris within the first week of production blasting at each bridge. Cease all blasting and painting operations on the bridge from which waste was generated, if sampling is not performed within the first week of production blasting.

Test composite samples for lead, chromium, cadmium and arsenic according to the U.S. EPA Publication SW 846 Method 1311 (TCLP). Provide the Chain of Custody and test results to the District Regulated Waste Engineer (DRWE) immediately after the test results are available. If the DRWE determines the blasting debris is hazardous, as defined below, provide the Engineer with the names of the

hauler and treatment facility. Perform all sampling and testing required by the hauler, treatment facility, or disposal facility.

The existing paint removed from bridges may contain lead, chromium, cadmium or arsenic. The Contractor is responsible for taking the proper safety precautions to ensure workers in this environment are properly protected.

1. Hazardous Waste. The blasting debris is hazardous if lead, chromium, cadmium or arsenic exceed any of the regulatory concentration limits shown below:

SW 846 Analyte	Regulatory Concentration Limit
Lead	5.0 mg/l
Chromium	5.0 mg/l
Arsenic	5.0 mg/l
Cadmium	1.0 mg/l

Label all the containers of hazardous blasting debris "HAZARDOUS". Post hazardous waste warning signs at obvious locations on the fenced enclosure.

The Office of Construction Administration will obtain a generator number assigned to the State. After the Office of Construction Administration obtains the generator number, arrange for the hauling, treating, and disposing of the hazardous waste. Use a firm licensed by EPA to haul and dispose of the hazardous waste. This firm is also responsible for providing the completed Uniform Hazardous Waste Manifest (EPA Form 8700-22, or current version).

In every case, properly dispose of all hazardous waste within 60 days after it is generated. If hazardous waste is not properly disposed of within 60 days, the Department will consider the Contactor in breach of its Contract and the Department will take the following actions:

a. Immediately suspend all abrasive blasting and painting of structural steel on the Project until hazardous waste is properly disposed.

b. Cease processing all pay estimates.

c. Forward a breach of contract notification to the Contractor's Surety.

The Contractor is responsible for fines or liens assessed by any governmental agency that has jurisdiction over the disposal of this hazardous waste material.

Decontaminate or dispose of all collection and containment equipment according to EPA guidelines.

The Contractor shall inform the Department when all hazardous waste has been removed from the Project so the EPA Site ID Number (Hazardous Waste Generator Number) can be deactivated.

2. Non-Hazardous Solid Waste. For all waste that is determined to be a Non-Hazardous Solid Waste by the DRWE, the Contractor is required to:

a. Before disposing of any material, provide the Engineer with documentation that the disposal facility is licensed by the EPA to accept non-hazardous solid waste.

b. Haul and dispose of the waste to the documented, non-hazardous solid waste facility.

c. Obtain from the disposal facility and provide the Engineer with a receipt that documents disposal of waste material at the licensed disposal facility.

d. Properly dispose of all waste within 60 days after it is generated.

514.14 Washing Shop Primer (QCP #7). Wash shop primed structural steel after it is erected and the concrete deck is placed and within 30 days of applying the intermediate coat.

Wash the steel with potable water. Use equipment capable of delivering the water at a nozzle pressure of at least 1000 pounds per square inch (7 MPa) and at a rate of not less than 4 gallons (15 L) per minute. The Contractor shall provide the Engineer with equipment specifications that verify both the delivery pressure and rate. Provide gauges on the equipment to verify the pressure during operation. Hold the nozzle a maximum of 12 inches (300 mm) from the surface being washed. The surface is clean when clear rinse water runs off the structure. After rinsing the surface, inspect for remaining dirt and rewash dirty areas until clean.

514.15 Handling. Deliver all paint and thinner in original unopened containers with labels intact. The Engineer or Inspector will accept containers with minor damage provided the container is not punctured. Thinner containers shall be a maximum of 5 gallons (19 L). Before use, provide the Engineer with shipping invoices for all painting materials used on the Project.

Supply containers of paint and thinner with labels clearly marked by the manufacturer to show paint identification, component, color, lot number, stock number, date of manufacture, and information and warnings as may be required by Federal and State laws.

Store paint at the temperature recommended by the manufacturer and in a storage facility that prevents theft. Provide thermometers capable of monitoring the maximum high and low temperatures inside the storage facility.

Before opening paint or thinner containers, check the labels to ensure the proper container is opened and the paint has not been stored beyond its shelf life. Do not use paint that exceeded its shelf life. Do not open containers of paint and thinner until required for use and then open the oldest paint of each kind first. Solvent used for cleaning equipment is exempt from the above requirements.

Do not use paint that has livered, gelled, or otherwise deteriorated during storage. Properly dispose of unused paint and paint containers.

514.16 Mixing and Thinning. Thoroughly mix all ingredients immediately before use with a high shear mixer (such as a Jiffy Mixer). Do not mix paint using paddle mixers, paint shakers, or an air stream bubbling under the paint surface. After mixing, carefully examine the paint for uniformity and to ensure that no unmixed pigments remain on the bottom of the container. Before use, strain the paint through strainers that remove skins or undesirable matter but not pigment.

Except for primer, mix paint as necessary during application to maintain a uniform composition. Continuously mix primer using an automated agitation system. Do not use hand-held mixers for primer paints.

Do not add thinner to the paint without the Engineer's or Inspector's approval, and only add thinner if necessary for proper application as recommended by the manufacturer's printed instructions. In the Engineer's or Inspector's presence, slowly add the amount of thinner recommended and supplied by the manufacturer to the paint during the mixing process. Do not mix other additives into the paint.

Add catalysts, curing agents, or hardeners that are in separate packages to the base paint only after thoroughly mixing the base paint. With constant agitation, slowly pour the proper volume of catalyst into the required volume of base. Do not pour off liquid that has separated from the pigment before mixing. Use the mixture within the pot life specified by the manufacturer and dispose of unused portions at the end of each workday.

514.17 Coating Application

A. General. Paint all structural steel, scuppers, expansion joints except top surface, steel railing, exposed steel piling, drain troughs, and other areas as shown on the plans. Paint galvanized or metalized surfaces if shown on the plans. Unless otherwise shown on the plans or specified below, apply paint to provide the specified coating thickness by brush and spray methods. Apply primer and intermediate paint per 708.01 and 708.02 to cover all visible steel surfaces. If gaps or crevices remain between adjacent coated steel surfaces after applying the intermediate coat, caulk according to 514.19. If brush and spray are not practical to paint places of difficult access, the Contractor may use daubers, small diameter rollers, or sheepskins.

Use daubers, small diameter rollers, or sheepskins to paint the following areas:

1. Where cross-frame angles are located within 2 inches (50 mm) of the bottom flange.

2. Where end cross frames are within 6 inches (150 mm) of the backwall.

3. Where there is less than 6 inches (150 mm) between the bottom of the bottom flange and the beam seat.

B. Application Approval. The Engineer or Inspector may inspect the initial application of the prime, intermediate, and final coats. If the Engineer or Inspector discovers defects, adjust the method of application to eliminate the defects then continue applying the coat.

C. Additional Information Pertaining to Shop Applied Paint. Apply a prime coat to all structural steel surfaces by brush or spray methods, including insides of holes, behind stiffener clips, areas that are to be embedded in concrete and contact surfaces of connection, and splice material that is to be fastened with bolts in the shop or field. For ASTM A709 Grade 50W and 70W steel embedded in concrete diaphragms, apply a prime coat to the entire surface area encased within the diaphragm and extending at least 12-in outside the diaphragm. Apply a mist coating from 0.5 to 1.5 mils (12.5 to 37.5 μm) on surfaces within 2 inches (50 mm) of field welds other than those attaching intermediate or end cross frames to beams or

girders. Apply one coat of primer to pins, pin holes, and contact surfaces of bearing assemblies, except do not paint those containing self-lubricating bronze inserts. Once the prime coat is dry, apply erection marks, using a thinned paint of a type and color that is completely concealed by, and compatible, with the second coat.

Do not handle or remove coated structural steel from the shop until the applied paint has met the requirements as specified by the paint manufacturer's printed instructions.

Reduce the thickness of thick films of inorganic zinc primer by screening, sanding, or sweep blasting. If the primer paint cured longer than 24 hours, apply a re-coating of primer paint according to the paint manufacturer's printed instructions. Abrasive blast and re-apply the primer to the affected area if "mud cracking" occurs. If "checking" occurs, abrasive blast and reapply the primer or remove the "checking" by screening and evaluate the area by adhesion testing.

If specified in the plans,furnish all necessary labor, materials and equipment to apply a three - coat paint system to Item 513 Structural Steel in the shop and touch up areas in the field.

Repair damage to the paint system caused during storage, transportation, erection, bolting, welding, forming, concrete placement, and form removal operation, according to C&MS section 514.22. Repair damage to the galvanized coating on the nuts, bolts and washers, in the field due to the bolt tightening or welding operations. Exercise extreme care while handling the steel during erection, and during subsequent construction of the bridge. Insulate the steel from the binding chains by softeners and pad all hooks and slings that are used to hoist/erect the steel members.

Coating of Bolted Faying Surfaces

Treat the surfaces indicated below as described in this specification

A. Faying surfaces of all bolted connections.

B. All internal contact surfaces of filler and splice plates.

C. Other surfaces indicated in the plans.

Coat the faying surfaces of bolted splices with inorganic zinc primer in the shop. After erection is complete, field apply the final coatings of epoxy intermediate coat and urethane protective coats to overlap the shop coatings shown in Figure 1 with the field coats shown in Figure 2. For bolted crossframes, leave a minimum of one inch step back from faying surfaces, for epoxy intermediate and an additional one inch for urethane top coat.

Remove and reassemble all shop bolted connections and shop bolted cross frames prior to the blasting and coating of the girders or beams. Separately blast and prime the parts, then reassemble and fully tighten the bolts using the turn of the nut method. After bolting is complete, shop apply the epoxy intermediate and urethane protective coats.

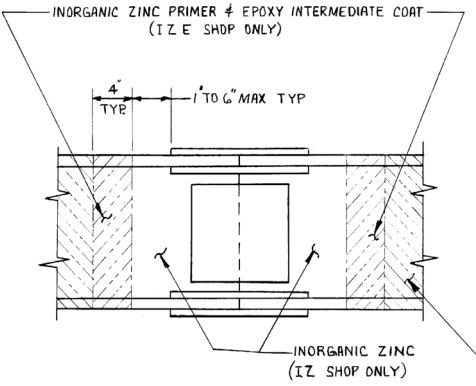


FIGURE-1
@ BOLTED SPLICE
SHOP COATINGS

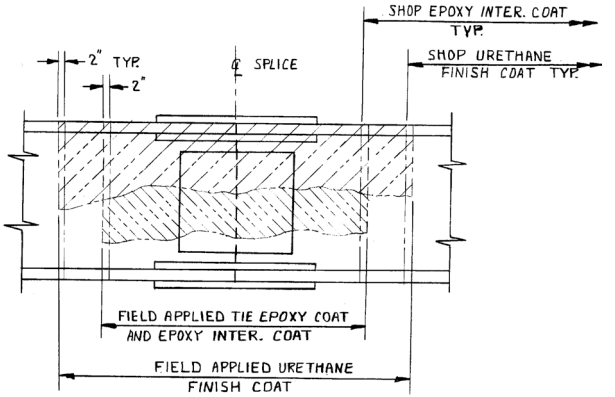


FIGURE-2
@ BOLTED SPLICE
FIELD COATINGS

After installation, solvent clean all galvanized nuts, bolts, and washers. Remove any contaminants on the nuts, bolts and washers, prior to the application of paint. Repair any damaged galvanized coating and remove any corrosion prior to the application of organic zinc by brush. Then apply the epoxy coat and the urethane coats.

Erection marks added by the fabricator to highlight or enhance the required steel stamped erection marks must be made without damaging the paint system. Apply Erection marks only after the finish coat is cured and remove at the end of the project. Erection marks may be applied to the faying surfaces. These marks to the inorganic coating need not be removed but must be of a paint supplied by the IZEU system manufacture.

Remove any oil, grease, asphalt cement, concrete or other contaminants from the surface of the IZEU system painted structural steel.

D. Surface Cleanliness. All surfaces to be painted shall be free of dust, dirt, grease, oil, moisture, overspray, and other contaminants. If the surface is degraded or contaminated, restore the surface before applying paint. In order to prevent or minimize degradation or contamination of cleaned surfaces in the field, the prime coat of paint shall be applied within 12 hours of the beginning of the abrasive blasting operation as required in surface preparation above, for steel which is cleaned and painted in the shop, the prime coat of paint shall be applied within 24 hours of the beginning of the blasting operation.

Schedule cleaning and painting when dust or other contaminants will not fall on wet, newly painted surfaces. Protect surfaces that do not receive paint or have already been painted from the effects of cleaning and painting operations. Before applying the next coat, remove overspray and bird droppings with a stiff bristle brush, wire screen, or a water wash with sufficient pressure to remove overspray and bird droppings without damaging the paint. Before applying the next coat, remove all abrasives and residue from painted surfaces with a vacuum system equipped with a brush type cleaning tool.

Remove all visible abrasives on the finish coat that came from adjacent work.

E. Brush Application. Apply the paint to produce a smooth coat. To ensure coverage, apply wet stripe coats using brushes, daubers, small diameter rollers or sheepskins to all edges, outside corners, crevices, welds, rivets, bolts, nuts and washers in addition to the spray application of each individual coating. Apply stripe coat of organic zinc primer and intermediate coat either before or after spray application of respective coats. Tint intermediate stripe coats another color that is applied after spray application. Apply stripe coats of the finish coats before spray application of the finish coats. Apply additional paint as necessary to produce the required coating thickness.

F. Spray Application (General). Apply paint using spray application as follows:

Keep spray equipment clean so that dirt, dried paint, solvents, and other foreign materials are not deposited in the paint film. Remove solvent left in the equipment before using the equipment.

Apply paint in a uniform layer with overlapping at the edges of the spray pattern. Paint the border of the spray pattern first, followed by painting the interior of the spray pattern. Complete painting a spray pattern before moving to the next spray pattern area. Within a spray pattern area, hold the gun perpendicular to the surface and at a distance that will ensure a wet layer of paint is deposited on the surface. Release the trigger of the gun at the end of each stroke. Each spray operator shall demonstrate to the Engineer or inspector the ability to apply the paint as specified before the operator sprays paint.

If mud cracking occurs, the affected area shall be cleaned to bare metal in accordance with surface preparation above and repainted. Use spray equipment recommended by the paint manufacturer and suitable for use with the specified paint. Provide adequately sized traps or separators to remove oil and condensed water from the air. Periodically drain the traps during operations. To ensure that the

traps or separators are working properly, test by blowing air from the spray gun for 30 seconds onto a white cloth or blotter held in a rigid frame. The Engineer or Inspector will verify the test results by inspecting the white cloth or blotter. If the cloth or blotter retains oil, water, or other contaminants, suspend painting until retests verify the problem was corrected. Perform this test at the start of each shift and at 4-hour intervals. This is not required for an airless sprayer.

Do not use spray application unless the operation is totally enclosed as required for abrasive blasting, to prevent overspray damage to the ground, public and private property, vegetation, streams, lakes, and other surfaces not to be painted.

G. Prime, Intermediate, and Finish Coat Application (QCP #5, #8, and #10). Apply paint as a continuous film of uniform thickness, free of all defects such as holidays, pin holes, mud cracking, checking, drips, runs, and sags. The Contractor is responsible for applying the manufacturer's paint as necessary to satisfy the above requirement. Repaint all thin spots or areas missed before the next coat of paint is applied.

Ensure that the paint manufacturer's printed instructions for the minimum times to handle, recoat and cure the individual coats for specified conditions and thicknesses are followed for each coat of paint before applying the next coat. Comply with the manufacturer's written instructions for the time interval between coats and apply the next coat when an additional coat will not cause detrimental film irregularities, such as lifting, wrinkling, or loss of adhesion of the undercoat. Do not exceed the following time intervals. If the prime coat is organic zinc, the maximum time between the prime and intermediate coats is 30 days. There is no maximum time between the prime and intermediate coats for an inorganic zinc primer. The maximum time interval between intermediate and finish coats is 13 days. These maximum recoat times include adverse weather days and the Engineer will not extend the times. The recoat windows begin with the initial application of each coating type inclusive of stripe coats. Additional applications of the same coat do not reset the recoat windows. The time interval ends with the application of the next full coat. The stripe coat does not end the time interval. If the next type of coating is not applied within the times stated above, remove the coatings and re-blast the steel according to SSPC-SP 10.

If requested by the engineer, perform one or both of the following test to determine the hardness and or the adhesion of an individual coating or the coating system:

1. Determine the hardness of an individual coat or the coating system by performing a Pencil Hardness Test according to ASTM D 3363. Meet or exceed scale of hardness HB for the coating.

2. Perform Adhesion Testing according to ASTM D 4541, Type 4. Meet or exceed 400 psi adhesion between coats or between the paint system and the substrate, or 400 psi cohesion within paint coats.

Stencil the Completion Date (month and year) of the finish coat and the letters of the applied paint system on the steel in 4 inch (100 mm) letters with black urethane paint. The appropriate letters for the paint systems are as follows:

System Comprised of	Letters
Inorganic zinc prime coat, epoxy intermediate coat, and urethane finish coat	IZEU
Organic zinc prime coat, epoxy intermediate coat, and urethane finish coat	OZEU

Apply the date and paint system at four locations near the end of each outside beam on the outside web visible from the road or as directed by the Engineer.

514.18 Removing Fins, Tears, or Slivers (QCP #6). Use a grinder to remove all fins, tears, slivers, or any other burred or sharp edges that become evident after applying the prime coat. Retexture ground surfaces to produce a profile from 1.5 to 3.5 mils (40 to 90 µm) and reprime ground surfaces before applying the intermediate coat. The Contractor may begin removing fins, tears, and slivers after blasting and before priming. Temperature and weather restrictions do not apply to removing fins, tears, and slivers, but do to applying the prime coat.

514.19 Caulking (QCP #9). After the intermediate coat cures and before applying the finish coat, caulk gaps or crevices up to 1/2 inch (13 mm) wide. Follow the manufacturer's recommendations for curing before applying the finish coat.

514.20 Dry Film Thickness (QCP #5, #8, and #10). Determine prime coat thickness; prime and intermediate coat thickness; and prime, intermediate, and finish coat thickness using a Type 2 magnetic gage as follows:

Measure paint thickness at separate, evenly spaced, spot measurement locations over each 100 square feet (9 m²) of area of structural steel. Locate five spot measurements on each of the following locations: top flanges; bottom flanges; webs; cross bracing; stiffeners; etc. At each spot location, take three gage readings of either the substrate or the paint. Move the probe 1 to 3 inches (25 to 75 mm) for each new gage reading. Discard an unusually high or low gage reading that is not consistently repeated. The spot thickness measurement is the average of the three gage readings.

The average of five spot measurements for each location in the 100 square foot (9 m²) area shall not be less than the specified thickness. No single spot measurement area shall be less than 80 percent of the specified minimum thickness nor greater than 150 percent of the maximum specified thickness when organic zinc is applied and 120 percent of the maximum specified thickness when inorganic zinc is applied. Any one of three readings which are averaged to produce each spot measurement, may under run or overrun by a greater amount. Take five spot measurements per location for each 100 square foot (9 m²) area as follows:

A. For all shop painted steel, regardless of size, randomly select and then measure one 100 square foot (9 m2) area within each 300 square foot (27 m²) unit of surface area that is painted.

B. For structures not exceeding 300 square feet (27 m²) in area, measure each 100 square foot (9 m²) area.

C. For structures not exceeding 1000 square feet (90 m²) in area, randomly select and then measure three 100 square foot (9 m²) areas.

D. For structures exceeding 1000 square feet (90 m²) in area, measure the first 1000 square feet (90 m²) as stated in section C and for each additional 1000 square feet (90 m²), or increment thereof, randomly select and then measure one 100 square foot (9 m²) area.

E. If the dry film thickness for any 100 square foot (9 m²) area (sections C and D) is not in compliance with the requirements of this subsection, then measure each 100 square foot (9 m²) area.

F. Measure other areas or revise the number of spot measurements as shown on the plans.

Each coat of paint shall have the following thickness measured above the peaks:

	Min. Spec. Thickness	**Max. Spec. Thickness**	**Min. Spot Thickness**	**Max. Spot Thickness (Inorganic Zn)**	**Max. Spot Thickness (Organic Zn)**
Prime	3.0 mils (75 µm)	5.0 mils (125 µm)	2.4 mils (60 µm)	6.0 mils (150 µm)	7.5 mils (188 µm)
Intermediate	5.0 mils (125 µm)	7.0 mils (175 µm)	4.0 mils (100 µm)	10.5 mils (263 µm)	10.5 mils (263 µm)
Subtotal	8.0 mils (200 µm)	12.0 mils (300 µm)	6.4 mils (160 µm)	16.5 mils (413 µm)	18.0 mils (450 µm)
Finish	2.0 mils (50 µm)	4.0 mils (100 µm)	1.6 mils (40 µm)	6.0 mils (150 µm)	6.0 mils (150 µm)
Total	10.0 mils (250 µm)	16.0 mils (400 µm)	8.0 mils (200 µm)	22.5 mils (563 µm)	24.0 mils (600 µm)

Remove paint with a film thickness greater than the maximum specified thickness unless:

The paint does not exhibit defects such as runs, sags, bubbles, or mud cracking, etc.
The manufacturer provides a written statement to the Engineer that the excessive thickness is not detrimental.

For any spot or average of five spots at any location of a 100 square foot (9 m²) area that exceeds the maximum spot thickness, either remove and replace the coating according to 514.22 or prove to the Office of Construction Administration that the excess thickness will not be detrimental to the coating system. In order to prove to the Office of Construction Administration that the excess thickness will not be detrimental to the coating system, the Contractor must provide the Office of Construction Administration with the following information.

Certified test data proving that the excessive thickness will adequately bond to the steel when subjected to thermal expansion and contraction. The thermal expansion and contraction test shall take place over five cycles of a temperature range from -20 to 120 °F (-49 to 49 °C). After the thermal contraction and expansion cycles have taken place, the tested system shall be subjected to pull off tests and the results compared to the results of pull off tests that have been performed on a paint system with the proper thicknesses.

Perform the adhesion tests according to ASTM D 4541 Type IV. Document the preparation methods for the panels, including profile and level of cleanliness. Document the application methods, conditions and if any thinner, (percentage), was used. Test the panels according to the following:

1. Lightly sand the coating surface and aluminum dolly, and apply a quick set adhesive. Document the type of adhesive.

2. Allow adhesive to cure overnight.

3. Scribe the coating and adhesive around the dolly before testing.

4. Make a minimum of 4 trials to failure and report the 4 trials. Reject trial if fracture occurs at the primer-substrate interface or pressure at failure is less than 400 pounds per square inch (2.8 MPa).

a. Describe the test specimen as substrate A, upon which successive coating layers B, C, D, etc. have been applied including the adhesive Y which secures the dolly Z to the topcoat.

b. Designate cohesive failures by the layers within which they occur as B, C, etc., and the percent of each.

c. Designate adhesive failures by the interfaces at which they occur as A/B, B/C, C/D, etc, and the percent of each.

In addition to the certified test results, the Contractor shall provide the Office of Construction Administration a written statement from the paint manufacturer stating that the excessive thickness is not detrimental.

If the Office of Construction Administration does not approve the excessive coating thicknesses or the Contractor elects not to provide the required written statement from the paint manufacturer and the certified test results when required, the Contractor shall remove and replace the coating. The removal and replacement of the coating shall be done as specified in 514.22.

514.21 Final Inspection

A. The Engineer will select locations for coating removal for inspection of surface preparation and dry film thickness. For all structures in which the supporting members are rolled beams or girders, remove a minimum of one location per 300 linear feet of beam line for webs and flanges and 2.5 percent of all cross frame assemblies and other secondary structural members shall be selected for destructive testing. For all other bridge types with structural steel, remove one location for every 2400 square feet of steel surface for destructive testing. Do not perform destructive testing on areas that have been painted with an inorganic zinc prime coat.

B. At the selected areas, the Engineer will perform total dry film thickness testing using a type 2 magnetic gage. If the dry film thickness for that spot does not meet the requirements of 514.20, additional measurements will be taken to determine the extent of the deficient coatings.

C. At the selected areas, where an organic zinc prime coat has been applied, remove at least 9 square inches (58 cm^2) of the new coatings by methods that will not damage the surface of the steel. Approved removal methods are scraping,

sanding, or the use of solvents. Do not use power tools. Perform removal while in the presence of the Engineer. The Engineer will document and photograph the selected areas after removal of the new coatings. If work is found not to be in conformance with the specifications and pertinent contract documents, additional locations may be selected for testing.

D. Make repairs of areas where the coatings were removed and other areas that were determined to be deficient. Make repairs according to 514.22. If the final destructive testing according to 514.21.C, reveals greater than 15 percent of the areas inspected are not in complete conformance with the specifications and pertinent contract documents, the Department will require that surface preparation and painting of the structural steel be completely redone to meet the requirements of the Contract Documents at no additional cost to the Department.

E. Final Acceptance shall be based upon the results of the surface preparation observations and dry film thickness measurements obtained from the final inspection. Final Acceptance will also take into consideration acceptable progressive project documentation and progressive field measurements in determining the final acceptability of the Bridge Paint System.

Inspection access to the test locations to perform the required final inspection measurements shall conform to the requirements of 514.10.

514.22 Repair Procedures. Remove paint and correct defects or damaged areas, including areas damaged by welding, and in areas that do not comply with the requirements of this specification. Correct defects and damaged areas using the same paint as originally applied except the Engineer may approve using organic zinc to repair inorganic zinc in the field. Retexture the steel to a near white condition and a profile between 1.5 to 3.5 mils (40 to 90 μm). Measure the profile immediately before applying the prime coat to ensure the profile is not destroyed during the feathering procedure. See 514.13.C.

Feather the existing paint to expose a minimum of 1/2 inch (13 mm) of each coat.

During the reapplication of the paint, apply paint as follows:

A. Apply the prime coat only to the surface of the bare steel and the existing prime coat exposed by feathering. Do not apply the prime coat to the adjacent intermediate coat.

B. Apply the intermediate coat only to the new prime coat and the existing intermediate coat exposed by feathering. Do not apply the intermediate coat to the adjacent finish coat.

C. Apply the finish coat only to the new intermediate coat and the existing finish coat that was feathered or lightly sanded. Do not apply the finish coat beyond areas that were feathered or lightly sanded.

At the perimeter of the repair area, apply the prime and intermediate coats using a brush. Apply the finish coat using either brush or spray.

The Contractor may need to apply several applications to obtain the proper thickness for each coat.

During the application of the prime coat, the paint shall be continuously mixed.

Perform all surface preparation and painting according to this specification. Instead of abrasive blasting, the Engineer may allow alternate methods of preparing the surface.

Blend repair areas with the adjacent coating and provide a finished surface in the patched areas that is smooth and has an even profile with the adjacent surface.

Submit, in writing, the method of correcting areas with runs to the Office of Construction Administration for approval.

514.23 Method of Measurement. The Department will measure Surface Preparation of Existing Structural Steel and Field Painting of Existing Structural Steel Prime Coat by the number of square feet (square meters) of structural steel painted or on a lump sum basis. The Department will measure Field Painting Structural Steel, Intermediate Coat and Field. Painting Structural Steel, Finish Coat by the number of square feet (square meters) or pounds (kilograms) of structural steel painted, or on a lump sum basis.

The Department will determine the number of pounds (kilograms) of new structural steel painted by the accepted pay weight of the new structural steel.

For steel beam and steel girder bridges, the Department will determine the surface area by taking a nominal measurement of the beams (i.e., two times the beam depth plus three times the flange width). In addition to this nominal measurement, the Department will add a percentage to account for incidentals such as cross frames, bearing assemblies, stiffeners, expansion joints, scuppers, etc. It is not necessary for the Engineer or Inspector to field measure every detail of the bridge to verify quantities. If there is a quantity dispute, exact field measurements of all painted surfaces and calculations will govern over the above percentage to account for incidentals.

For extremely complex bridges, such as trusses, the Department will pay for painting on a lump sum basis.

The Department will measure grinding fins, tears, slivers on existing structural steel by the number of man hours expended by the workers actually doing the grinding and will include the time when the workers are performing grinding and repairing prime coat and not limited to only the actual grinding duration (i.e., the Department will include all hours of the workers when assigned to grinding regardless of actual grinding time). The Department will not measure grinding fins, tears, and slivers on new steel but will consider it incidental to unit price for the new steel.

514.24 Basis of Payment. The Department will pay for accepted quantities at the Contract prices as follows:

The Department may consider paint as eligible for payment for material on-hand as specified in 109.10, however, only paint that the Contractor can prove to the Engineer will be used during the construction season is eligible for payment. The Contractor shall provide the Engineer calculations indicating the total square feet (square meter) of steel to be painted during the construction season. The Contractor shall also provide calculations showing the total number of gallons (liters) required.

If the Contractor causes damage or injury to public or private property, the Department will not pay for restoring the property to its original condition.

The Department will not pay for repairing adjacent coatings damaged during the blasting operation.

The Department will not pay for removing and replacing an area of coating because a spot or maximum average thickness exceeds the maximum spot thickness.

The Department will not pay for additional testing required by any hauler, treatment facility, disposal facility or landfill.

The Department will pay for caulking under Field Painting Structural Steel, Intermediate Coat.

The Department will pay for final inspection access, test area preparation and test area repair at each selected area under Final Inspection Repair. The Department will not pay for accessing, inspecting, and repairing areas that are not found to be in conformance with the specifications and pertinent contract documents.

All other requirements of this specification are considered incidental to the work.

Item	Unit	Description
514	Square Foot (Square Meter) Lump Sum	Surface Preparation of Existing Structural Steel
514	Square Foot (Square Meter) Lump Sum	Field Painting of Existing Structural Steel, Prime Coat
514	Square Foot (Square Meter) Lump Sum, Pound (Kilogram)	Field Painting Structural Steel, Intermediate Coat
514	Square Foot (Square Meter) Lump Sum, Pound (Kilogram)	Field Painting Structural Steel, Finish Coat
514	Man Hour	Grinding Fins, Tears, Slivers on Existing Structural Steel
514	Each	Final Inspection Repair
514	Square Foot (Square Meter) Lump Sum Pound (Kilogram)	Shop Painting and Field Touch-Up of Structural Steel

ITEM 515 PRESTRESSED CONCRETE BRIDGE MEMBERS

515.01 Description
515.02 Fabricator Approval Procedure
515.03 Levels of Fabricator Qualification

515.01 Description. This work consists of preparing shop drawings, furnishing and manufacturing prestressed concrete bridge members, testing, fabricator performed quality control, documentation, shop coating, and handling, transporting, storing, and erecting prestressed concrete bridge members. Prepare shop drawings and erect prestressed concrete bridge members, according to Item 501 and the additional requirements specified below. Shop coating shall conform to Item 512.

515.02 Fabricator Approval Procedure. Select fabricators that are pre-qualified and evaluated by the Office of Materials Management (OMM) according to Supplement 1079 and listed by the Department before the Contract letting Date.

515.03 Levels of Fabricator Qualification. There are three levels of fabricator qualification. OMM will classify each fabricator at the highest level of fabrication it is qualified to perform.

Level	Description of Capabilities
1	Straight strand prestressed box beam members
2	Straight strand prestressed I-beam members
3	Draped strand prestressed I-beam members

515.04 General. Produce all members according to Item 511, except as otherwise specified herein.

515.05 Fabricator Documentation Responsibility. The fabricator shall keep and maintain records for each project bid line number concerning:

A. Fabricator plant approval.

B. Shop drawing approval.

C. Material test reports.

D. Welding qualifications.

E. Quality Control Plan (QCP) according to Supplement 1079.

The fabricator shall provide access to the above records for audit, inspection, and copying. Provide a copy of the complete records at the completion and final shipment of the work. The Fabricator shall retain all documentation for at least 5 years from the date of final shipment from the fabrication shop.

The fabricator shall document all Quality Control (QC) activities to verify the fabrication conforms to the specification requirements. QC activities include material quality checks, dimensional checks, weld inspections, strand tensioning procedures, release procedures, post-pour inspections, concrete strengths at release of strand and final strength of concrete before shipment, cleaning operations, coating applications, final QC inspections, repairs and all other QC procedures required to provide a prestress concrete member conforming to the specifications.

Supplement 1079 defines the quality control plan evaluation process and quality control plan enhancement process

The Department will perform a quality assurance (QA) evaluation of the fabricator's quality control performance using forms in Supplement 1079 and will include both validation of the fabricator's actual records of inspection and Department inspection.

515.06 Shop Drawings. Provide shop drawings conforming to 501.04 and the following requirements.

Include all details, dimensions, dimensional tolerances, and size of materials, lifting devices, inserts, reinforcing steel supports, fabricator incorporated reinforcing, contractor supplied items, piece mark diagrams for field connection and erection of any steel and all prestress members, and all other information necessary for the complete fabrication and erection of the prestressed members. Show all items that will be incorporated into each prestressed member, including Contractor supplied hardware. All steel hardware to be incorporated into the prestressed member and added after Contract Sale shall be galvanized according to 711.02; and meet clearances specified in 509.04.

Provide mill certs to the fabricator, prior to the prefabrication meeting.

Provide the detensioning procedure and pattern conforming to 515.16.

515.07 Pre-Fabrication Meeting. At least 3 days after the Department receives shop drawings, conduct a pre-fabrication meeting at the fabricator's facilities, or another location agreed to by all parties.

As part of the pre-fabrication meeting request, provide a initial fabrication schedule for the prestressed beam project including:

A. Start date for fabrication of the project

B. Expected phasing of fabrication, if any

C. Number of workdays for the project and length of work day

D. Quality control final inspection date

The fabricator's production manager, quality control specialists (QCS) for the project, the Department's inspector, and the Contractor, or its designated representative, shall attend the meeting. The meeting is to review fabrication issues, including information on shop drawings, previous QC/QA inspection issues, QC and Quality Assurance inspection hold points, unique and special fabrication items, and special processes. The QCS will conduct the meeting and record and distribute meeting minutes that document all issues discusses. Begin fabrication when all meeting issues have been resolved.

Office of Material Management may waive the pre-fabrication meeting if accepted by the Fabricator and the Contractor. If Contractor submitted shop drawings do not comply with the requirements of 515.06, no pre-fabrication meeting can be scheduled or waived.

515.08 Materials. Furnish materials conforming to:

Reinforcing steel	509
Concrete	515.15
Portland cement	701.01 thru 701.09
Aggregate *	703.02
Air-entraining admixture	705.10
Chemical admixtures for concrete	705.12
Prestressing steel	711.27
Transverse tie rods	711.01
Welded wire reinforcement	709.12

* For fine aggregate, use natural sand for members without a separate wearing course. Modify coarse aggregate as follows:

Do not allow more than 0.4 percent deleterious materials.

For gradation, use No. 6, 67, 68, 7, 78, or 8 size coarse aggregate.

515.09 Materials Approval. The fabricator shall control, test, and validate material requirements for all materials either incorporated into the prestressed fabricated item or supplied under Item 515 as component parts to the fabricated items. The fabricator shall provide Supplement 1079 documentation to the inspector at the time of final inspection.

The Department will not sample materials at the fabricator's shop for Department approval. The Department will randomly sample materials to verify the fabricator's performance.

515.10 Casting Beds. Use steel or concrete casting beds set above grade to ensure the beds remain above the accumulation of water resulting from production and curing operations. Design beds and abutments capable of safely resisting all forces applied to them without appreciable movement or deflection. These forces include compression and eccentric forces due to end-jacking operations, forces at hold down points when draped strands are used, and downward forces due to the dead weight of the members. Verify casting bed losses annually and provide the data as an update to the Fabricator's Quality Control Plan.

515.11 Weather Conditions During Production. Make temperature change adjustments to initial strand tensioning according to PCI Quality Control Manual 116.

A. Cold Weather. Conform to the requirements of this subsection if the ambient air temperature is below 50 °F (10 °C). Heat mixing water, aggregates, or both as necessary to produce a concrete temperatures from 50 to 70 °F (10 to 21 °C) when placed. Do not allow water heated above 150 °F (66 °C) to directly contact the cement. Do not place concrete against forms, reinforcing steel, prestressing strand, or other hardware materials with a temperatures below 32 °F (0 °C).

Immediately prior to final stressing, obtain the temperature correction factor for prestressing strands using a thermometer that has been calibrated against a NIST-traceable thermometer. Define the frequency, location, and thermometer in the Quality Control Plan.

Do not place concrete when the ambient temperature with sustained wind chill factor at the point of concrete placement is below 0 °F (-18 °C).

B. Hot Weather. If the ambient temperature is above 90 °F (32 °C) cool the mixing water, aggregates, or both, as necessary to produce a concrete temperature from 70 to 90 °F (21 to 32 °C). Do not place concrete against forms, mild reinforcing steel, prestressing strand, or other hardware materials with a temperature greater than 120 °F (49 °C).

Water fog spray forms, mild reinforcing steel and strand just prior to placing the concrete. Cover beams immediately after casting to prevent surface drying.

Do not place concrete when the ambient temperature at the point of concrete placement is above 100 °F (38 °C).

C. Inclement Weather. If a rainfall event begins after placement of concrete in the forms has begun, provide cover and complete only the beam that had concrete in it when the rain began. Provide immediate cover over previously poured concrete, not yet cured. Resumption of concrete placement is permitted after the rainfall stops.

515.12 Equipment. Provide hydraulic jacks of sufficient capacity and stroke to tension strands. Use either single or multiple strand tensioning. Provide tensioning jacks equipped with automatic cutoff valves and equipped with 6 inch (150 mm) minimum diameter gages that provide readings at 500 pound (2 kN) increments. Calibrate gages for the jacks with which they are to be used. Have a graph or table showing the calibration available for the inspector. Calibrate jacks according to a method acceptable to the Laboratory at least every 6 months or as required by the Director. Maintain calibration documentation as part of the project's QC inspection records.

Design the jacking system to ensure uniform stress in all strands. If simultaneously tensioning multiple strands, use approved types of dynamometers to equalize the initial stress on all strands before applying the full tensioning load with the master jack Provide dynamometers with sufficient capacity to ensure that the desired readings are in the middle to upper range.

515.13 Inspection Facilities. The fabricator shall provide the inspector office accommodations conforming to the following requirements:

A. Minimum floor area of 120 square feet (11 m^2).

B. Minimum ceiling height of 7 feet (2.1 m).

C. Adequate working and storage facilities, work space, lighting, electrical outlets, lockable files or cabinets with key.

D. Heating and cooling capable of maintaining an ambient air temperature between 68 °F (20 °C) and 80 °F (27 °C).

E. Secure internet access.

515.14 Construction Methods. Use metal forms capable of producing members within the tolerances shown on the plans. Forms made of material other than metal may be used for bulkheads and voids and may be used for a single project for prestressed members requiring non-standard forms. Ensure that the surfaces of the forms in contact with the concrete are smooth and the joints between panels are tight. The soffit form shall have a plane surface at right angles to the vertical axis of the members and have the two bottom edges beveled 3/4 inch (19 mm) with a triangular strip built into the forms. Increase the length of the forms for elastic shortening and normal concrete shrinkage, and design the forms to accommodate this movement.

Provide water-resistant formwork for box beam voids constructed of a material that resists breakage and deformation during placement of concrete. Provide form material that does not excessively increase the dead load of the beams.

Prevent the release agent from contacting the prestressing strands or reinforcing steel.

Install and assemble reinforcing steel according to the approved shop drawings. If authorized, weld reinforcing cages using welders qualified to AWS D1.4. Do not weld epoxy coated or galvanized reinforcing steel unless approved by Office of Material Management. Repair all coating areas damaged by welding according to the coating manufacturer's instructions. Reject reinforcing steel with a loss of cross-section of reinforcing caused by welding.

Provide a protective covering for the prestressed steel from the elements until the strand is pulled into the bed. Accurately place strands in the positions shown on the shop drawings. Do not use strands with kinks, bends, nicks, broken wires, scale, loose rust, or other defects. The fabricator may use slightly rusted reinforcing steel provided the rust is not sufficient to cause visible pits. Before placing the concrete, carefully clean the strands of all dirt, grease, oil, or other foreign matters. Do not splice strands within a member.

Tension strands uniformly to the stress indicated on the shop drawings. If multiple stands are stressed simultaneously, use dynamometers to equalize the initial stress on all strands before applying full tension load with master jack. Measure the required stress in the strands using the calibrated jacking equipment gages, and check the measured stress by the elongation of the strands. If the stress from the gages and the measured elongation are not within a 5 percent tolerance of the design, stop stressing the strands and determine the reason for the differences. The quality control specialist shall keep a record of the jacking forces and elongations of all strands. Secure the strands by suitable anchorage devices capable of developing at least 85 percent of the ultimate strength of the strands. The anchorage shall not allow the strand to slip after the tensioning operation.

If using draped strands, the loss of stress due to friction shall not exceed 5 percent. Tension the strands at both ends. The quality control specialist shall measure the

loss due to friction by a procedure approved by the Office of Material Management. Place hold-down points within 3 inches (90 mm) of the locations shown on shop drawings and within 12 inches (0.3 m) of the locations shown on the plans.

Unless otherwise shown in the plans, do not install inserts or holes in the beam web within a distance of 1.5 times the beam height from the end of the beam.

515.15 Concrete. The fabricator shall provide concrete mix designs to Office of Materials Management. The submittal will include:

A. Test data showing the mix achieves the required 28-day strength when cured by methods used for member fabrication. The strength of the concrete for the mix design approval and during production is determined using a set of three, 4 × 8-inch cylinders.

B. w/c ratio (maximum =0.40)

C. A design and maximum slump. For SCC concrete, provide a slump flow range in accordance with ASTM C1611, provide the following:

1. Visual Stability Index (VSI) – Provide a VSI of 0 or 1 as listed in ASTM C 1611 for acceptance of the mix design

2. J-Ring- Test J-ring passing ability in accordance with ASTM C 1621. The measured difference between the slump flow and J-ring flow must be two inches or less to be acceptable.

3. Static Segregation- Test for static segregation according to ASTM C 1712. The measured penetration must be one-half inch or less to be acceptable.

4. Column Segregation- Test for column segregation according to ASTM C 1610. Provide a static segregation ≤15.0%..

D. Test data showing the mix design achieves 2000 coulombs or less at 90 days when tested according to AASHTO T277. Use samples for the test that were mixed without corrosion inhibitors and that were cured with the same methods that will be used to produce the prestressed concrete bridge members. Do not apply additional cure to samples that have reached the required design strength.

Changes in proportioning, cement, pozzolans or aggregate will require retesting and resubmittal. Office of Materials Management may waive the retests. Provide the waiver request in writing and include all information for the new mix design and a comparison to the previously tested and approved mix design(s).

Deliver concrete according to Item 499 except that 499.03 and 499.04 does not apply. The plastic air content of the concrete before placement shall be 6 ± 2 percent. If the Department questions the concrete's placed air content, obtain cores from the prestressed member and have hardened air testing performed by an independent testing lab acceptable to the Department. Beams with hardened air contents below 4 percent will be rejected. Add an approved corrosion inhibiting admixture at the approved dosage and document the dosage that has been incorporated into each batch of concrete.

Maintain the mix design slump during production. Segregation of the mix is not acceptable. Do not exceed the maximum water-cement ratio during concrete

production. When using admixtures to increase the slump, use Type F or G as described in 705.12. Do not use calcium chloride or admixtures containing calcium chloride.

Sample and test the conventional or SCC concrete for prestressed concrete members as specified in Table 515.15-1. For SCC mixes, perform slump flow in accordance with ASTM C 1611 and provide a VSI of 0 or 1. Fabricate test specimens in accordance with ASTM C 1758 per Table 515.15-1. Perform ASTM C 1621 and C 1712 at least once per bed line, per day, during concrete production, and within the tolerances listed in 515.15.C:

TABLE 515.15-1, TEST SPECIMEN REQUIREMENTS

Cubic Yards per Bed	Sampling Frequency	Number of Cylinders Required
Less than or equal to 30 cubic yards	First and last load per bed	Minimum of 4
30 to 60 cubic yards	First and last load per bed plus one random sample.	Minimum of 6
Greater than 60 cubic yards	First and last load per bed plus 2 random samples.	Minimum of 8

Determine strength, for both strand release and final shipping, by testing a group of cylinders, which consists of one cylinder from every sample location. Each group of cylinders shall have an average strength of what is specified in the shop drawings, and no individual cylinder shall have less than 95 percent of the specified strength.

The inspector may require additional cylinders from locations were the concrete does not conform to mix design or placement requirements. Include these additional cylinders in the group of cylinders for determining release and final strength.

The fabricator may place concrete in the bottom flange of a box beam before placing the interior forms and reinforcement for the upper portion of the member, provided continuous concrete placement is not interrupted for more than 45 minutes.

Screed the top surfaces of non-composite members and finish the surface with a burlap drag or other means to provide a uniform surface with a gritty texture suitable for waterproofing.

Screed the top surface of composite members and finish the surface with a wire broom, in a transverse direction and penetrating the finished surface approximately 1/4 inch (6 mm) + 1/16 inch (1.5 mm) – 1/8 inch (3 mm) at a maximum spacing of 1 -1/2 inches (38 mm).

Immediately after final concrete placement and surface finishing, protect the concrete surface with a suitable enclosure until application of live steam or radiant heat. Assure the enclosure's ambient temperature is at least 50 °F (10 °C). Assure the plastic concrete's temperature before initial set doesn't rise more than 10 °F (5 °C) per hour. Limit the total rise before initial set to less than 40 °F (22 °C) and the maximum temperature to 100 °F (38 °C). Record the times and concrete temperatures before initial set.

For curing with low-pressure steam, do not apply live steam directly onto the concrete forms if it causes localized high temperatures.

For accelerated curing with radiant heat, apply radiant heat using pipes circulating steam, hot oil, or hot water, or using electric heating elements. Minimize moisture loss by covering all exposed concrete surfaces with plastic sheeting, 705.06, or by applying a liquid membrane curing compound, 705.07, to all exposed concrete surfaces. Before bonding field-cast concrete or other materials in the finished structure, remove the curing compound from the shear faces of composite members and other surfaces.

Start initial application of the steam or heat 2 to 4 hours after final concrete placement. If using retarders, start applying the steam or heat 4 to 6 hours after final concrete placement. If determining the time of initial set according to ASTM C 403, these time limits do not apply. Record and report the actual time of concrete placement of the last load, placement of enclosure and initial set time.

Apply live steam or radiant heat so the ambient temperature within the curing enclosure does not gain more than 40 °F (22 °C) per hour until reaching the curing temperature. Do not exceed 160 °F (71 °C). Only use a maximum temperature of 180 °F (82 °C) if the fabricator documents to the Department that delayed ettringite or alkali silica reaction is not at issue. Maintain the maximum curing temperature until the concrete has reached the required release strength. De-tension the strands immediately upon completing the accelerated curing. Keep a record of the time the application of heat began and curing temperatures throughout the entire curing process.

Provide a final surface finish free of bug holes, honeycombing, and other defects. Neatly fill cavities in the exposed surface of beams with mortar of the same cement and fine aggregate mixed in the same proportions as used in the concrete being finished.

Clean the concrete and apply and cure the grout according to the manufacturer's published recommendations. Reject beams with honeycombing that impairs the member's performance. Follow the requirements of Item 512.03 for beams to be sealed with epoxy urethane.

515.16 Release of Prestressing Strands. Do not release prestressed strands until the concrete reaches a minimum strength of 4000 pounds per square inch (28.0 MPa), or plan defined release strength. Determine strength of concrete by testing cylinders produced according to AASHTO T 23 and cured in the same method as the member. Test cylinders in the fabricator's laboratory. Assure all tested cylinders obtain the required strength of 4000 pounds per square inch (28.0 MPa) or the plan defined release strength. Provide the Department the ability to witness the cylinder testing by notifying the inspector before testing.

Before releasing prestressed strands, loosen or remove forms and hold-downs and all other attachments restricting either horizontal or vertical movement of prestressed members. Release the strands immediately upon completing accelerated curing. Heat release and burn the strands simultaneously between each beam and at all exposed points between anchorages, and follow an approved pre-determined pattern, to equalize the forces being transferred to the various areas of the cross-

section of the member. Submit any alternative strand release plans during the prefabrication meeting to OMM for approval. For heat release, use a low-oxygen flame to uniformly heat at least a 4 inch (100 mm) long section of strand before completely cutting the strand.

515.17 Fabrication Tolerances. Construct all members to conform to the following tolerances.

TABLE 515.16-1, BEAM DIMENSIONAL TOLERANCES

Description	Box Beam	I Beam
Length of beam	±1/8" per 10 ft (1 mm/m) max ±3/4" (19 mm)	±1/8" per 10 ft (1 mm/m) max ±1" (25 mm)
Depth of beam	±1/4" (6 mm)	-1/4" (6 mm) +1/2" (13 mm)
Depth of I beam flange including fillets	N/A	±1/4" (6 mm)
Beam (box)/Flange (I) Flange Width	±1/4" (6 mm)	-1/4" (6 mm) +3/8" (10 mm)
Flange Thickness excluding fillets		
a) Top	-0 +1/2" (13 mm)	±1/4" (6 mm)
b) Bottom	-1/8" (3 mm) +1/2" (13 mm)	±1/4" (6 mm)
Width Web	N/A	-1/4" (6 mm) +3/8" (10 mm)
Width beam walls	-1/4" (6 mm) +3/8" (10 mm)	N/A
Width of Void	±1/2" (13 mm)	N/A
Height of Void	±1/2" (13 mm)	N/A
Box Beam Diaphragm spacing	±2" (50 mm)	N/A
Deviation from True Vertical	±1/8" (3 mm)	1/8" per ft (8 mm per m)
Deviation from Skew Angle	±1/2" (13 mm)	±1/2" (13 mm)

TABLE 515.16-2, BEAM ACCESSORY TOLERANCES

Description	Box Beam	I Beam
Position of railing anchors	±1/4" (6 mm)	N/A
Position of lifting devices	±6" (150 mm)	±6" (150 mm)
Positions of anchor dowels and tie rods, inserts	±1/2" (13 mm)	±1/2" (13 mm)
Deviation from skew angle	±1/2" (13 mm)	±1/2" (13 mm)

TABLE 515.16-3, BEAM STRAND TOLERANCES

Description	Box Beam	I Beam
Strand tendon position	±1/4" (6 mm)	±1/4" (6 mm)
Strand CG position	±1/4" (6 mm)	±1/4" (6 mm)

TABLE 515.16-4, REINFORCING STEEL TOLERANCES

Description	Box Beam	I Beam
Clear cover	-0 +1/4" (6 mm)	-0 +1/4" (6 mm)
Splice lengths	-1 1/2" (38 mm)	-1 1/2" (38 mm)
Stirrup spacing in anchorage zone	±1/4" (6 mm)	±1/4" (6 mm)
Stirrup spacing outside anchorage zone	±1" (25 mm)	±1" (25 mm)
Stirrup extension above top flange	-1/2" (13 mm) +1/4" (6 mm)	0 +1" (25 mm)
Reinforcement extension beyond beam end	-3/4" (18 mm) +0	-3/4" (18 mm) +0

TABLE 515.16-5, BEAM SWEEP AND CAMBER TOLERANCES

Description	Box Beam	I Beam
Horizontal Sweep	±1/8" per 10 ft max ±3/4"	±1/8" per 10 ft max ±1"
Max Gap between beam	1"	N/A
Deviation from Design camber (Dt) [1]	+ Sacrificial Haunch [2] or 1/8" per 10 ft max +1/2" or -1/2"	+ Sacrificial Haunch [2] or – 1"
Variation in camber between beams in same span	max 1/2"	N/A

[1] Design camber (Dt) calculated in accordance with 511.07
[2] Unless otherwise noted, Sacrificial Haunch thickness is 2"

515.18 Prestressed Member Acceptance and repair. Throughout the fabrication process reject all prestressed members not meeting specification requirements except as noted below for camber.

The Department will not accept for shipping, prestressed members with measured camber exceeding the Design Camber (Dt), used to establish the seat elevations, according to 511.07, by more than the Sacrificial Haunch thickness nor camber more than one inch less than Design Camber, until a corrective work plan has been approved by the Engineer. The plan shall be signed, sealed and dated by an Ohio Registered Engineer and shall include all revised plan information necessary to place the deck to the plan thickness. If the prestressed members are acceptable, exclusive of the deviation from Design Camber, the Department will pay for all costs incurred resulting from measured camber exceeding or more than 1 inch under Design Camber calculated for the actual beam age at the time of deck placement, as Extra Work, 109.05.

Use the Precast/Prestress Concrete Institute's Manual for the evaluation and repair of Precast, Prestressed Concrete Bridge Products MNL-137-06 as a general guide.

The Department will not accept for shipping, prestressed members with measured camber exceeding the Design Camber (Dt), used to establish the seat elevations, according to 511.07, by more than the Sacrificial Haunch thickness, until a corrective work plan has been approved by the Engineer. The plan shall be signed, sealed and dated by an Ohio Registered Engineer and shall include all revised plan

information necessary to place the deck to the plan thickness. If the prestressed members are acceptable, exclusive of the deviation from Design Camber, the Department will pay for all costs incurred resulting from measured camber exceeding Design Camber calculated for the actual beam age at the time of deck placement, as Extra Work, 109.05.

515.19 Handling Storage, Transportation, and Erection. Handle, store, transport, and erect the members in an upright position. The direction of support reactions during storage and transportation shall be the same as the member will experience in its in-service position. Do not ship prestressed members until the concrete obtains its 28-day design strength and the inspector's approval.

Provide at least 30 inches (762 mm) horizontally between each beam for inspection. Provide at least 8 inches (200 mm) of vertical clearance from the bottom. Use storage support locations as close as practical to the in-service support locations. During storage, provide unyielding horizontal supports and bracing capable of maintaining the members in a vertical position.

Transportation support locations shall be the sole responsibility of the fabricator with respect to member stresses and safe delivery to the job site. Obtain the Director's written approval to transport the members in a position other than vertical.,

Provide lifting devices capable of withstanding the required loads to lift and erect the members. During erection, accurately place the prestressed beams on their bearings to ensure a uniform load on all bearings. When shifting a member, lift the member up completely off of its bearings. Temporarily brace the first I-beam erected to its substructure support units in the vertical position before releasing the beam from the crane. Tie each subsequent I- beam to the previously braced beam(s). Provide bracing after erection adequate to prevent sliding, tipping, or other movement that may result from high winds, creeping down the grade, or other causes, until placement of the diaphragms. Within any one day erect and brace at least 2 adjacent members in any one span before suspending operations for the day.

Place box beams to ensure a correct fit of the keyways and to ensure proper grouting of the keyways. After placing the beams and installing tie devices, fill the longitudinal keyways using non-shrink keyway grouts, 705.22, approved by OMM. Mix, install, and cure the grout according to the manufacturer's published recommendations to obtain a design compressive strength of 5000 pounds per square inch (34.5 MPa).

Do not allow vehicular load on an individual prestressed concrete box beam until the grout in the keyway obtains the specified design strength of 5000 pounds per square inch (34.5 MPa).

At the Director's discretion, repair or replace members damaged by improper handling, storage, transportation, or erection.

515.20 Safety Requirements. Provide effective safety measures to prevent injuries to personnel due to breakage of strands or failure of anchorage devices during the tensioning operations. Provide adequate protection and assure the OMM inspector can perform inspection of beams and manufacturing processes. The Department inspector will report any inadequate safety precautions to the plant QCS

and to OMM if fabricator remedial action is not taken. OMM inspectors will follow safety rules established by the fabricator, at a minimum. Where fabricator safety rules interfere with the inspectors' duties, the process should be altered to allow the inspections to be performed while maintaining the required level of safety.

515.21 Method of Measurement. The Department will measure Prestressed Concrete Bridge Members by the number of members.

The Department will measure the intermediate diaphragms by the number of each placed.

515.22 Basis of Payment. Payment for prestressed concrete beams include all inserts, sleeves, fittings, reinforcing steel fully or partially encased in the members, threaded rods, embedded inserts, embedded bearing sole plates, temporary bracing, fixed anchor dowels, and all transverse tie rods necessary to complete this work. The Department will consider all costs associated with all structural steel, including bolts, nuts, washers and plate washers for steel intermediate diaphragms, as well as concrete and reinforcing steel for cast-in-place concrete intermediate diaphragms as incidental to the intermediate diaphragms.

The Department will pay for expansion joint end diaphragms, semi-integral diaphragms, pier diaphragms, bearing load plates, bearing pads, and other expansion materials, separately.

The Department will not pay for repaired or replaced members damaged by improper handling, storing, transporting, or erecting.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
515	Each	Prestressed Concrete Non- Composite Box Beam Bridge Members, Level 1
515	Each	Prestressed Concrete Composite Box Beam Bridge Members, Level 1
515	Each	Straight Strand Prestressed Concrete Bridge I-Beam Members, Level 2
515	Each	Draped Strand Prestressed Concrete Bridge I-Beam Members, Level 3
515	Each	Intermediate Diaphragms

ITEM 516 EXPANSION AND CONTRACTION JOINTS JOINT SEALERS AND BEARING DEVICES

516.01 Description
516.02 Fabrication
516.03 Coating
516.04 Materials
516.05 Expansion and Contraction Joints

516.06 Joint Sealers
516.07 Bearing Devices
516.08 Method of Measurement
516.09 Basis of Payment

516.01 Description. This work consists of fabricating, assembling, constructing, coating, and installing expansion and contraction joints, vertical extension of structural expansion joints, joint sealers, or bearing devices of the type and size specified.

516.02 Fabrication. Fabricate metal joint armor and metal bearings according to Items 513. Select a fabricator that is at least pre-qualified at level SF. The Department will base final acceptance of fabricated members on the Engineer's approval that the fabricated items that can be successfully incorporated into the structures. Submit mill test reports for structural steel, steel castings, bronze, and sheet lead certified according to 501.06.

516.03 Coating. Coat exposed steel bearings attached to structural steel to match the coating of the adjoining structural steel. Metallize bearings with 100 percent zinc wire or galvanize bearings according to 711.02 that are to be attached to concrete beams. Repair damage to metallized or galvanized coatings according to 711.02.

Coat metal parts of expansion joints not part of extensions to existing steel expansion joints with metalized 100 percent zinc wire or galvanize according to 711.02. Prepare the surface to be coated and apply coating as required by The Society of Protective Coatings SSPC-CS-23.00(1). Apply coating to a minimum thickness of 6 mils. The vertical extensions to existing steel expansion joints are not to have any protection and the horizontal extensions to existing steel expansion joints are to match the existing protection.

Repair metalized coatings damaged during fabrication by removal of the damaged coating and reapplication as specified above. Repair metalized or galvanized coatings damaged during shipping, construction, or field welding according to 711.02.

516.04 Materials. Furnish materials conforming to:

Structural steel	513
Bearing bolts and anchor rods	711.10
Painting	514
Joint sealer, hot applied	705.04
Preformed elastomeric compression stager	705.11
Neoprene Sheeting	705.13
Steel castings	711.07
Sheet copper	711.15
Bronze	711.16, 711.17, 711.18
Sheet lead.	711.19
Preformed bearing pads	711.21
Elastomeric bearings	711.23
Preformed fillers	705.03
Swedged anchor bolts or bars*	711.10
Non-Shrink,Non-Metallic Grout	705.20

* Fabricated by deforming a minimum of 20 percent of the embedded bolt surface with deformations whose radial dimensions are 15 to 20 percent of the bar diameter.

516.05 Expansion and Contraction Joints. Ensure that expansion joints are completely open for the dimension specified for their full length. Remove stones, forms, or other materials that interfere with expansion.

Finish the surface adjacent to preformed expansion joints to a smooth, uniform surface. Use methods that do not interfere with the free compression of the joint material to anchor the expansion joint materials. The joint material shall neatly fill the space, and have a uniform thickness for the full extent of the joint.

For Integral and Semi-Integral Abutment Expansion Joint Seals, install a 3 foot wide neoprene sheet for waterproofing of the backside of the joint between the integral backwall and the bridge seat at locations shown in the plans. Secure the neoprene sheeting to the concrete with 1 1/4 inch by #10 gage (length × shank diameter) galvanized button head spikes through a 1 inch outside diameter, #10 gage galvanized washer. Maximum fastener spacing is 9 inches. Use of other similar galvanized devices, which will not damage either the neoprene or the concrete, will be subject to the approval of the Engineer.

Center the neoprene strips on all joints. For horizontal joints, secure the horizontal neoprene strip by using a single line of fasteners, starting at approximately 6 inches from the top of the neoprene strip. For the vertical joints secure the vertical neoprene strip by using a single vertical line of fasteners, starting at approximately 6 inches from the vertical edge of the neoprene strip nearest to the centerline of roadway.

For vertical joints, install two additional fasteners at 6 inches, center to center, across the top of the neoprene strip on the same side of the vertical joint as the single vertical row of fasteners is located. The vertical neoprene strips shall completely overlap the horizontal strips. Lap lengths of the horizontal strips that are not vulcanized or adhesive bonded, shall be at least 1 foot in length, or 6 inches in length if the lap is vulcanized or adhesive bonded. No laps are acceptable in vertically installed neoprene strips. The neoprene sheeting shall be 3/32 inch thick general purpose, heavy-duty neoprene sheet with nylon fabric reinforcement.

516.06 Joint Sealers. Before applying joint sealer to the surface, clean the concrete of foreign matter, curing compounds, oil, grease, dirt, free water, and laitance and clean steel by sand blasting.

Apply joint sealer with a minimum depth of 1 inch (25 mm) at its thinnest section. Fill joints to within 1/4 inch (6 mm) of the roadway surface.

Separate joint sealer from contact with asphalt concrete using a barrier of foil or other material that is impervious to the joint sealer.

As required to prevent bonding of the joint sealer with a joint surface, place a suitable bond breaker barrier before applying the joint sealer.

Remove joint sealer that did not bond to the joint face as intended within 24 hours after placing. Clean the joint by sandblasting and reseal the joint.

Mix and place joint sealer according to the manufacturer's instructions. Provide the Engineer with a copy of the manufacturer's instructions.

Protect joint sealer with an impervious masking tape during the application of concrete protective coatings containing mineral spirits.

516.07 Bearing Devices. For sliding plates, lubricate the sliding surfaces with flake graphite, and superimpose plates on each other with their edges flush.

Install each bridge bearing to within ± 0.125 inch of its marked centerlines in the horizontal plane and oriented to within an angular tolerance of 0.20 rad. (1 degree).

Accurately set, level and align elastomeric bearings, bearing plates, and bolsters. Set bearing plates and bolsters on 0.125 inch (3 mm) thick sheet lead, conforming to 711.19.

Set bearing plates or bolsters on bridge seat areas that are flat and smoothly finished. If the bridge seat area is high or uneven, use a bushhammer or grinder followed by thin film of portland cement mortar or paste to fill the pitted surface to bring the seat area to the proper elevation and provide a level, even surface. If the bridge seat area is low, use steel plate shims of the same bearing area as the bearing plates and bolsters to bring the seat area to the proper elevation.

Set elastomeric bearing pads directly on the concrete surface. If the beams seats are sealed with an epoxy or non-epoxy sealer prior to setting the bearings, do not apply sealer to the concrete surfaces under the proposed bearing locations. If these locations are sealed, or membrane cured, remove the sealer or membrane cure to the satisfaction of the Engineer before setting the bearings. Perform this removal at no expense to the Department.

Position rockers, elastomeric bearings, and rollers so that, when the completed bridge is at 60 °F (16 °C), the rockers and elastomeric bearings are vertical and the rollers are centered on the base. If the steel is erected at an ambient temperature higher than 80 °F or lower than 40 ºF and the bearing shear deflection exceeds 1/6 of the bearing height at 60 ºF ± 10 ºF, raise the beams or girders to allow the elastomeric bearings to return to their undeformed shape at 60 ºF ± 10 ºF.

Set anchor bolts for bearing devices that are clear of the beam or girder flanges, in the concrete after erecting the main structural steel, except as specified below for bearing devices at abutments. Place reinforcing steel in the bridge seat to not interfere with the drilling of anchor holes. Accurately set anchor bolts in the holes and embed the anchor bolts in non-shrink, non-metallic grout. Until the anchors' are installed, prevent water from entering and or freezing in the anchor bolt holes.

If structural steel interferes with the setting of the anchor bolts, set the anchor bolts before erecting the steel. The Contractor may determine the location of the bolts by using a template and form holes or embed the bolts when placing concrete or, drilling holes in the hardened concrete.

Install anchor bolts to project at least 1/4 inch (6mm) beyond the nut when tightened. Damage or burr the threads on the projecting end of the bolt after the nut is tightened. The bolt threads shall not extend to the planes of the contact surfaces between the connected parts. Include the length of two additional threads to the

specified thread length of the bolt to allow for thread runout. Washers no thicker than 1/4 inch (6mm) are permitted under the nut.

Permanently fasten bearing devices to the abutments, steel beams, or girders after backfilling the abutments to within 2 feet (0.6 m) of the top of the bridge seat.

Where the load plate of an elastomeric bearing is to be connected to the structure by welding, control the welding so that the plate temperature at the elastomer bonded surface does not exceed 300 °F as determined by use of pyrometric sticks or other temperature monitoring devices.

516.08 Method of Measurement. The Department will measure the specified items by the number of each, square feet (square meters), pounds (kilograms), or feet (meters).

For all Structural Steel Expansion joints, elastomeric compression seals and joint sealer, the Department will measure the length in feet horizontally along the joint centerline and between the outer limits of the joint.

For the Semi-Integral Abutment Expansion Joint Seal, the Department will measure, in feet, the total length of the joint between the diaphragm and the abutment.

For deck resurfacing, the Department will measure Structural Steel Expansion Joints extending vertically by the actual horizontal length of joint.

516.09 Basis of Payment. The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
516	Foot or Pound (Meter or Kilogram)	Structural Steel Expansion Joints
516	Foot (Meter)	Structural Expansion Joints Including Elastomeric ___ Seals
516	Foot (Meter)	Elastomeric Compression Seals for Structural Steel Joints, ___ Width
516	Foot (Meter)	Vertical Extension of Structural Expansion Joints
516	Square Foot (Square Meter)	___ Preformed Expansion Joint Filler
516	Foot (Meter)	Joint Sealer
516	Each, Foot, Square Foot, Pound (Meter, Square Meter, Kilogram)	Bearing Devices
516	Each, Square Foot (Square Meter)	___ inch (___ mm) Elastomeric Bearing Pad
516	Each	Elastomeric Bearing with Internal Laminates Only
516	Each	___ × ___ × ___ Elastomeric Bearing with Internal Laminates and Load Plate ___ × ___ × ___

516	Square Foot (Square Meter)	1/8-inch (3 mm) Preformed Bearing Pads

ITEM 517 RAILINGS

517.01 Description. This work consists of furnishing, constructing, coating, and erecting the type of railing specified. This work also consists of providing and galvanizing structural posts, anchors, and connections.

517.02 Fabrication. Fabricate railing according to Item 513. Select a fabricator that is at least prequalified at level SF. The Department will base final acceptance of fabricated members on the Engineer's approval that the fabricated items that can be successfully incorporated into the structures. Submit mill test reports for structural steel, steel castings, bronze, and sheet lead certified according to 501.06.

517.03 Materials. Furnish materials conforming to:

Concrete, Class QC 2	499, 511
Reinforcing steel	509, 709
Structural steel	513
Preformed fillers (sponge rubber or PVC)	705.03, 711.28
Steel tubing	707.10
Paint	708
Metal deep beam rail	710.06
Ductile iron casings	711.13
Aluminum	711.20
Timber	711.26
Stainless steel fasteners.	730.10
Pipe	748.06

Submit mill test reports for structural steel and aluminum according to 501.06.

517.04 Construction Methods, General. Construct railings as shown on the plans. Install posts for metal railings normal to the grade line. Install the tops of railings parallel to the grade line.

Remove or release shoring or falsework supporting the superstructure before placing railing that has no expansion joints or that is on the concrete parapet.

517.05 Steel and Iron Railings. Unless specified to paint according to Item 514, galvanize all parts of steel and iron railings.

Erect metal deep beam rail elements according to Item 606.

517.06 Aluminum Railings. Use alloy conforming to 711.20 for aluminum railings.

Give the extreme outer surfaces of cast railing posts a 40-grit finish. The Contractor is not required to provide a special finish for other portions of railings. Do not scratch, dent, or cause other damage to railings that may affect the durability or appearance of the railing.

Use galvanized steel anchor bolts and hexagon nuts conforming to 711.02. Coat the entire projecting portion of anchor bolts and fill the space between the bolts and post base with an aluminum-impregnated caulking compound.

Where aluminum contacts concrete or stone masonry, thoroughly coat the contact surfaces with an aluminum-impregnated caulking compound or with a heavy asphalt material paint pigmented with aluminum powder or paste thereby providing an aluminum appearance. Where aluminum or aluminum shims contacts different metal, thoroughly coat the contact surface with an aluminum-impregnated caulking compound or place a synthetic rubber impregnated fabric gasket between the metals.

Weld only where shown on the plans using inert gas shielded metal-arc or tungsten-arc method without flux, or by other approved methods.

517.07 Method of Measurement. The Department will measure Railing by the number of feet (meters) of railing including end posts. If deep beam guardrail is used, the Department will measure the length of railing between the first posts off the bridge excluding the first posts off the bridge. If hand rails or tubular backup rails are used, the Department will not measure any portions extending beyond the first posts off the bridge. If twin steel tube bridge railing is used, the Department will measure the length of the railing between the second post off the bridge including the second post. If Three Steel Tube Bridge Railing is used, the Department will determine the number of feet of railing as the total length of the middle tube railing as measured along the traffic face on each side of the bridge.

517.08 Basis of Payment. The cost of hand rails or tubular backup rails extending beyond the measured limits are included for payment in the unit price bid for the measured length.

The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
517	Foot (Meter)	Railing (___)

ITEM 518 DRAINAGE OF STRUCTURES

518.08 Scuppers
518.09 Excavation
518.10 Method of Measurement
518.11 Basis of Payment

518.01 Description. This work consists of constructing drainage systems.

518.02 Fabrication. Fabricate scuppers according to Item 513. Select a fabricator that is at least pre-qualified at level SF. The Department will base final acceptance of all fabricated members on the Engineer's approval that the fabricated items can be successfully incorporated into the structures. Submit mill test reports for structural steel, steel castings, bronze, and sheet lead certified according to 501.06.

518.03 Materials. Furnish materials conforming to:

Scuppers, structural steel and cast steel	513
Metal pipe	707
Plastic pipe	707.33, 707.45
Other metals	711
Prefabricated Geocomposite Drain (PGD)	712.16
Geotextile fabric, Type A	712.09
Reinforced thermosetting resin pipe	707.80

Furnish pipe specials of a grade at least as high as the type of pipe specified.

Furnish porous backfill consisting of gravel, stone, or air-cooled blast furnace slag, with a No. 57 size gradation according to Table 703.01-1. The sodium sulfate soundness loss shall not exceed 15 percent.

Furnish ACBFS conforming to Supplement 1027.

518.04 General. As shown on the plans, connect all parts to new or existing sewers or other outlets.

When installing to superstructure, take into account the deflection of spans under full dead load.

518.05 Porous Backfill. Place porous backfill as shown on the plans. When not shown on the plans, place backfill at least 2 feet (0.6m) thick behind the full length of abutments, wing walls, and retaining walls. Measure the thickness of porous backfill normal to the abutment or wall face. The Contractor may leave undisturbed rock or shale within 18 inches (0.5 m) of the abutment or wall. Place 2 ft^3 (0.23 m^3) of bagged No. 3 aggregate at each weep hole to retain the porous backfill. Place the porous backfill for the full width of the trench and extend it to the bottom of the approach slab or base, as shown in the plans. Place porous backfill in loose lifts not to exceed 12 inches. Run a plate compactor or tamper over the top of each lift for consolidation of approximately 85% of original layer thickness. If placed in loose lifts greater than 12 inches, flood the porous backfill at the appropriate moisture content for consolidation of approximately 85% of original layer thickness.

518.06 Prefabricated Geocomposite Drain (PGD). Do not use PGD on Integral Abutments or above the beam seat elevation on Semi Integral Abutments.

A. Preparation. Prepare the surface of the wall or abutment, on which the PGD is to be placed, to be free of soil, debris, and excessive irregularities that prevent continuous contact between the wall surface and the PGD.

B. Placement. Place PGD strips to provide continuous coverage over the face of the wall. Unroll PGD directly onto the prepared surface. Do not drag the PGD across the ground. Tension the PGD to remove any creases or wrinkles. Do not expose PGD to weather or direct sunlight for longer than 5 days. Place the geotextile fabric side to face toward the backfill or retained soil.

Construct the PGD in horizontal or vertical courses. Place the PGD in direct contact with the wall and secure to the surface using either adhesives per manufactures recommendation or nails as follows. Secure with 2 inch (51 mm) or longer concrete nails along with washers or wood battens of not less than 9 square inches (5887 square mm). Space the concrete nails no more than 3 feet (0.9 m) apart, both horizontally and vertically. Use at least one horizontal row of nails in each horizontal course of PGD, or use at least one vertical column of nails in each vertical course of PGD. Do not affect the drainage area and the downward flow in the drain by the adhesive or fasteners.

C. Splicing and covering. Form horizontal or vertical seams between courses by utilizing the flap of geotextile extending from one course and lapping over the flap on that of the next course. Securely fasten the overlapped flaps with a continuous strip of 3 inch (76 mm) wide, waterproof, plastic tape.

Where splices are necessary without a geotextile flap, place and center a 12 inch (0.3 m) wide continuous strip of geotextile over the seam and fasten with continuous strips of 3 inch (76 mm) wide, waterproof, plastic tape.

As an alternative method of splicing, either horizontally or vertically, rolls of PGD may be joined together by turning back the geotextile flap at the roll edges and interlocking the drainage core approximately two inches. Fold the flap under and tape it beyond the seam with 3 inch (76 mm) wide, waterproof, plastic tape. Shingle lap the core and fabric in the direction of water flow.

To prevent soil intrusion, cover all exposed edges of the PGD core by tucking the geotextile flap over and behind the core edge. Alternatively, a 12 inch (0.3 m) wide strip of geotextile may be used to wrap the edge, taping it to the geotextile side 8 inches (203 mm) in from the edge with a continuous strip of 3 inch (76 mm) wide, waterproof, plastic tape and folding the remaining 4 inches (102 mm) over and behind the core edge. Caps (bottom, top, or end) provided by the manufactures can also be used according to manufacturer's instructions.

Construct all seams, splices, and caps to prevent the backfill material from entering the PGD.

D. Connecting to Weep Holes and Drainage System. Connect the PGD to the drainage system as shown on the plans or per manufacturer's recommendations if not shown in the plans. Maintain a positive outlet for the water in the PGD at all locations.

Do not seal, block or restrict weep holes with the PGD. If available, use weep hole fittings provided by the manufacturer and installed to the manufacturer's

instructions. If the PGD core is not perforated at the weep hole location, make a hole in the PGD core matching the diameter of the weep hole or larger to accommodate the pipe or fitting. When making holes in the core, do not damage the geotextile fabric.

Use manufacturer provided outlet fittings that transition between the PGD and the outlet pipe, and prevent material from entering the outlet pipe. If manufacturer fittings are not available, provide smooth-lined or corrugated outlet fittings according to manufacturer's recommendations. Fasten and seal outlet fittings to the wall drains according to manufacturer's recommendations.

E. Repair. Patch or replace damaged PGD. Remove the damaged area and place a PGD patch and splice the edges according to 518.06.C. If the damaged portion is larger than 50 percent of the PGD roll width, cut across the entire width of the roll to remove the damaged portion and splice according to 518.06.C.

If damage is limited to tears in the geotextile fabric, place a geotextile patch extending 6 inches (152 mm) beyond the damaged area in all directions or to the edge of the roll, and seal the entire perimeter with 3-inch (76 mm) wide, waterproof, plastic tape.

Replace and repair damaged PGD at no additional expense to the Department.

F. Backfilling. Replace or repair any PGD component that is damaged during the backfilling operation. Use hand operated compaction equipment to compact the backfill within 1-foot (0.3m) of the PGD.

518.07 Pipe. For drain pipe leading down from the superstructure, use either galvanized steel pipe, 748.06, or plastic pipe, 707.45, or reinforced thermosetting resin pipe, 707.80. Provide specials, elbows, tees, wyes, and other fittings essential for a complete and satisfactory installation of the same material and quality as the pipe. Construct watertight joints of adequate strength. In steel pipe, weld joints or use clamp-type couplings having a ring gasket. In plastic pipe, make joints according to the applicable ASTM standard. In reinforced thermosetting resin pipe, make joints according to manufacturer guidelines and procedures. Securely fasten the pipe to the structure with hanger or clamp assemblies that are galvanized according to 711.02.

Place subsurface pipe as shown in the plans. If the plans require drainage pipe in the porous backfill, provide plastic pipe conforming to 707.33.

For corrugated metal pipe, perforated specials are not required and the Contractor may make bends with adjustable elbows conforming to the thickness requirements of the pipe specifications.

518.08 Scuppers. Construct secure and watertight connections, including the connections to adjacent concrete. Provide castings, true to form and dimension. Weld the joints of structural steel scuppers. Galvanize scuppers according to 711.02.

518.09 Excavation. Excavate all material encountered to the dimensions necessary to provide ample space at least to install pipe or other drainage facility behind abutments and for outlets.

518.10 Method of Measurement. The Department will measure Porous Backfill and Porous Backfill with Geotextile Fabric, by the number of Square Yards

(Square Meters), Cubic Yards (Cubic Meters) or lump sum. The Department will measure Prefabricated Geocomposite Drain by the number of Square Yards (Square Meters) or lump sum. The Department will measure pipe specials by the same method as the pipe. If pipe is by the foot (meter), the Department will measure the pipe along its centerline.

The Department will measure all Square Yard (Square Meters) items as the area of the abutment or wall being covered for drainage

518.11 Basis of Payment. The cost to backfill, if not separately itemized in the Contract, and excavation is incidental to the drainage facility that necessitates them.

The Department will include bagged aggregate with porous backfill for payment.

The Department considers all items to place the Prefabricated Geocomposite Drain including surface preparation, tape, fasteners, adhesives, outlet fittings or other support material, incidental to the Prefabricated Geocomposite Drain.

The Department will pay for perforated and non-perforated pipes for the Prefabricated Geocomposite Drain as separate pay items per 518.07.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
518	Cubic Yard (Cubic Meter) or Lump Sum	Porous Backfill
518	Cubic Yard (Cubic Meter) or Lump Sum	Porous Backfill with Geotextile Fabric
518	Square Yard (Square Meter) or Lump Sum	Prefabricated Geocomposite Drain
518	Foot (Meter)	___ inch (___ mm) ___ Pipe, Including Specials
518	Each	Scuppers, Including Supports
518	Pound or Foot (Kilogram or Meter)	Trough Horizontal Conductors
518	Pound or Foot (Kilogram or Meter)	Pipe Horizontal Conductors
518	Foot (Meter)	___ inch (___ mm) Pipe Downspout Including Specials

ITEM 519 PATCHING CONCRETE STRUCTURES

519.01 Description
519.02 Materials
519.03 Removal of Disintegrated Concrete
519.04 Preparation of Surface
519.05 Placing of Reinforcing Steel
519.06 Placing, Finishing, and Curing of Concrete

519.07 Method of Measurement
519.08 Basis of Payment

519.01 Description. This work consists of removing all loose and disintegrated concrete; preparing the surface; furnishing and placing reinforcing steel including welded steel wire fabric, dowels, and expansion bolts; placing forms; and placing concrete patches, including curing of same.

519.02 Materials. Furnish materials conforming to:

Concrete, Class QC 5	499, 511
Dowels	709.01, 709.03, or 709.05
Reinforcing steel	509
Welded steel wire fabric	709.10 or 709.12

519.03 Removal of Disintegrated Concrete. Remove all loose and disintegrated concrete from the areas to be repaired in such a manner and to such an extent as to expose a sound concrete surface. Provide patches at least 4 inches (100 mm) deep, except on top horizontal surfaces, provide patches at least 3 inches (75 mm) deep. Remove sound concrete (beneath the disintegrated concrete) for a depth of not less than 1/4 inch (6 mm) and not more than 1 inch (25 mm), provided that the above minimum depth of patch is maintained. Make square or, preferably, slightly undercut shoulders having a depth of not less than the specified minimum depth of the patch at the edges of all patches.

Only use pneumatic or hand tools that give results satisfactory to the Engineer in the removal of the disintegrated concrete and in preparing and shaping the areas to be patched.

If working around reinforcing steel, avoid damaging or debonding any reinforcing steel that is un-corroded and completely embedded in sound concrete. Ensure there is no shattering of the concrete, beyond the area to be patched. If the area around the reinforcing steel is either embedded in unsound concrete or the reinforcing steel is exposed during removal, continue to remove the concrete around the reinforcing steel to completely expose the reinforcing and provide at least a 1 inch (25 mm) clearance around the reinforcing. The 1 inch (25 mm) clearance may be reduced to 1/2 inch (13 mm) if the patching concrete uses No. 8 coarse aggregate.

Adequately support reinforcement that is loose, and tie it back into place. Replace reinforcement damaged during removing concrete.

519.04 Preparation of Surface. After removing all disintegrated and loose concrete, properly shape the area to be patched, and install dowels or expansion bolts as necessary to hold the wire fabric to be used in the patch. Thoroughly clean the surface of the area to be patched and all exposed reinforcing steel of all dirt, dust, all loose rust or other foreign materials with water, air under pressure, or any other method that produces satisfactory results. Thoroughly drench the surface with clean water. Before placing the concrete, allow the surface to dry to a damp condition.

519.05 Placing of Reinforcing Steel. The Department will not require reinforcement for patches on top horizontal surfaces. Reinforce patches on other surfaces with welded steel wire fabric either 2 × 2 inch (50 × 50 mm) using wire size number W 0.9, or 3 × 3 inch (75 × 75 mm) using wire size number W 1.4. Cover the

entire area of the patch with the fabric, and place and hold the fabric approximately 1 inch (25 mm) from the completed exposed surface of the patch. Securely fasten the fabric to the reinforcing steel in the original structure exposed in removing the disintegrated concrete. If no reinforcing steel is exposed or it is not practical to fasten the fabric to exposed steel, install dowels or expansion bolts at a distance not to exceed 18-inch (0.5 m) centers in both directions, and fasten the fabric to these dowels or bolts.

519.06 Placing, Finishing, and Curing of Concrete. Place and finish Class QC 5 concrete according to Items 499 and 511.

Remove the forms within 24 hours after placing the concrete, and finish all exposed surfaces by rubbing to match the surrounding concrete. Apply membrane curing according to 511.14, Method B, immediately after rubbing the surface.

After curing and before final acceptance, sound all patched areas. Remove and replace all unsound or visibly cracked areas.

519.07 Method of Measurement. The Department will measure Patching Concrete Structures by the number of square feet (square meters) of the exposed surfaces of all completed patches, irrespective of the depth or thickness of the patch. If a patch includes corners or edges of members such as beams, curbs, and columns, the Department will measure all of the exposed surfaces. If a patch extends completely through a member of a slab, the Department will measure both exposed surfaces.

519.08 Basis of Payment. The Department will pay for accepted quantities at the contract price as follows:

The Department will not pay for replacing reinforcement damaged during concrete removal.

The Department will not pay for removing and replacing of patched areas that are unsound or visibly cracked.

Item	Unit	Description
519	Square Foot (Square Meter)	Patching Concrete Structures

ITEM 520 PNEUMATICALLY PLACED CONCRETE- SHOTCRETE

520.11 Preconstruction Testing
520.12 Shotcrete Placing
520.13 Curing
520.14 Inspection and Testing
520.15 Method of Measurement
520.16 Basis of Payment

520.01 Description. This work consists of removing all loose and disintegrated concrete; surface preparation; furnishing and placing reinforcing steel, welded steel wire fabric, and dowels; furnishing and placing pneumatically applied concrete; and curing for new work, rehabilitation, or repair.

520.02 Materials. Furnish materials conforming to:

Reinforcing steel	509
Portland cement	701.01 through 701.05, 701.09
Micro-silica	701.10
Fly ash	701.13
Slag Cement	701.11
Fine aggregate	703.02, 703.03
Air-entraining admixture	705.10
Chemical admixture for concrete	705.12
Welded steel wire fabric	709.10 or 709.12
Swedged anchor bolts	711.10

Use water for concrete mixing free from sewage, oil, acid, strong alkalis, vegetable matter, clay, and loam. Potable water is satisfactory for use in concrete. Non-potable water will meet the requirements of ASTM C 1602. Water from a reclaiming system will contain no more than 0.06% chlorides. Test the non-potable and reclaiming system water prior to the start of shotcrete production. Provide certified test data to the Engineer, at least 21 days prior to shotcrete production.

520.03 Shotcrete Mix Design. Only use mix designs accepted by the Department and the following requirements.

A. Provide a Shotcrete job mix conforming to the following:

1. Compressive strength. Provide a compressive strength, at a minimum, of 2000 psi at 3 days, and 4000 psi at 7 days, or as per plan requirements.

2. Migrating Corrosion Inhibitors. Each admixture shall be accompanied by manufacturer's written certification meeting ASTM C 1582. Dosage rate will follow manufacturer's recommendations.

B. Provide prepackaged shotcrete materials in accordance with ASTM C 1480 from a single manufacturer. The minimum compressive strength for shotcrete is 2000 psi at 3 days and minimum of 4000 psi at 28 days. Follow the manufacturer's recommendations for storing the material on site, do not allow the prepackaged materials to become wet prior to use. Submit certified test data to the Engineer for approval prior to use that and meets the requirement of Table 520.3.B-1.

TABLE 520.3.B-1, SHOTCRETE CONCRETE PROPERTIES

Hardened Properties	Test Method	Requirement
Slant Shear Bond Strength @ 28 days	ASTM C 882 Modified (1)	2000 psi (14 MPa), min.
Drying Shrinkage @ 28 days	ASTM C 157 Modified (2)	0.08%, max.
Rapid Chloride Permeability @ 28 days	ASTM C 1202 (3) / AASHTO T 277(3)	750 coulombs, max.
Volume of Permeable Voids @ 28 days	ASTM C 642(3)	10%, max.
Freeze-Thaw Resistance @ 300 cycles	ASTM C 666, Procedure A	95% RDM, min.
Flexural Strength @ 28 day	ASTM C 78	900 psi (6 MPa), min.
Compressive Strength @ 3 days	ASTM C 1604	2000 psi (14 MPa), min.
Compressive Strength @ 28 days	ASTM C 1604	4000 psi (28 MPa), min.

(1) No epoxy bonding agent used.
(2) ICRI Guideline No. 03733, "A Guide for Selecting and Specifying Materials for Repair of Concrete Surfaces", 1"x1"x10" prism, air cured
(3) Either Rapid Chloride Permeability or Volume of Permeable Voids can be used.

Provide dry mix with migrating corrosion inhibitors. Each admixture shall be accompanied by manufacturer's written certification meeting ASTM C 1582. Dosage rate will follow manufacturer's recommendations.

520.04 Delivery of Materials. Deliver all materials in their original containers bearing the manufacturer's label, specifying date of manufacturing, batch number, trade name, and quantity. Each shipment will be accompanied by a Safety Data Sheet (SDS).

520.05 Storage of Materials. Stock and store any material necessary to perform the work to prevent damage by the elements. Keep the storage space clean and dry per Manufacturer's recommendations.

520.06 Equipment. Provide shotcrete equipment capable of delivering the premixed material accurately, uniformly and continuously through the delivery hose.

A. Mixing: Provide dry-mix shotcrete using a rotary type or pressure vessel gun with a continuous-type predampener, capable of thoroughly mixing the shotcrete mixes in sufficient quantity to maintain shotcreting continuity and a moisture range of 3 to 5% prior to discharging into the gun. Operate all equipment in accordance with the manufacturer's recommendations.

Provide wet-mix shotcrete using a positive displacement pump (swing tube). Concrete for wet-mix shotcrete placement may be supplied by an approved concrete batch plant and delivered by truck concrete mixers. Supply plant batched concrete and delivery equipment meeting the requirements of ASTM C 94. Where the concrete mixture is prepared on-site, use mixing equipment with a calibrated water meter capable of mixing prepackaged shotcrete material. Supply concrete mixes

used in shotcrete placement having a W/Cm ratio between 0.35-0.45. The maximum 90-minute limit will be implemented for wet-mix shotcrete after the addition of water to the mixture. Use of hydration control admixtures (HCA) may be used to extend the 90 minutes as approved in the job mix approval prior to use.

B. Air Pressure, Dry-Mix Process. Use a compressor capable of delivering a sufficient volume of oil-free air at the pressure shown in Table 520.6.B-1. Maintain steady pressure throughout the placing process.

Use a water pump or a water booster pump with the size and capacity to deliver water to the nozzle with a pressure at least 15 psi more than the required air pressure.

The values shown in the Table 520.6.B-1 are based on a hose length of 150 feet with the nozzle less than 25 feet above the delivery equipment. Increase operating pressure approximately 5 psi for each additional 50 feet of hose and approximately 5 psi for each 25 feet the nozzle is raised.

TABLE 520.6.B-1, COMPRESSOR CAPACITIES

Compressor Capacity, CFM	Hose Diameter, in.	Maximum Size of Nozzle Tip, in.	Operating Air Pressure Available, psi
250	1	3/4	40
315	1-1/4	1	45
365	1-1/2	1-1/4	55
500	1-5/8	1-1/2	65
600	1-3/4	1-5/8	75
750	2	1-3/4	85

C. Air Pressure, Wet-Mix Process. Use a compressor capable of delivering a sufficient volume of oil-free air to operate the pump at a line pressure between 100 psi and 300 psi. Use delivery hoses between 1-1/2 inches and 3 inches in diameter. Use mixing equipment capable of thoroughly mixing the materials in sufficient quantity to maintain continuous placement.

520.07 Submittal Requirements. Submit to the Engineer for review at least two weeks before beginning the work.

A. Evidence the contractor has successfully executed no less than five projects with similar size and scope over the last five years. The information provided is to include a statement of the type of work, and contact information for Engineer or Owner who have knowledge of the execution of the work and present condition of the work.

B. Documentation and owner references, verifying the qualifications of the nozzlemen. Personnel designated as nozzlemen on the job are required to document a minimum of one year of experience in the application of shotcrete on a comparable project and hold a current certificate for ACI Shotcrete Nozzleman, either dry-mix process or wet-mix process, as corresponds to the process indicated. Certifications for all nozzlemen to be utilized on the job.

C. Documentation the supervisor has experience supervising more than one comparable project including written documentation and owner references, verifying the qualifications.

D. JMF information and a list of materials and quantities. Include list of Admixture literature used. Indicate the admixture type and the manufacturer's recommendations for mixing the admixtures with JMF.

E. Methods and materials used for Depth control quality measures.

520.08 Removal of Concrete. In areas to be repaired, remove all loose, soft, honeycombed, and disintegrated concrete, plus a minimum of 1/4 inch (6 mm) to a maximum of 1 inch (25 mm) depth of sound concrete. Remove additional concrete as necessary to permit the placement of the minimum specified shotcrete thickness of not less than 1-1/2 inches (38 mm), except on top horizontal surfaces of not less than 3/4 inch (19 mm). Once initial removals are made, undercut all exposed reinforcing bars. Undercutting will expose the full circumference of the exposed reinforcing bar. Provide a clearance of 3/4 inch (19 mm) between the exposed reinforcing bar and the surrounding concrete.

Remove all heavy corrosion and scale from the reinforcing bars with wire brush or abrasive blasting. A minor amount or tightly adhered rust may be left in place.

Saw cut edge locations to a minimum of 1/2 inch (13 mm). Maintain an edge location depth of not less than the specified minimum depth for all repair areas.

Only use pneumatic, hand tools, or hydrodemolition equipment to obtain results satisfactory to the Engineer in the removal of concrete and in preparing and shaping the areas to be repaired.

If working around reinforcing steel, avoid loosening the steel, or shattering the concrete around it, beyond the repair area.

520.09 Reinforcement. For existing reinforcing bar that have been cut or having lost 20% or greater section loss, splice in supplement reinforcing bar of equal bar size. Use mechanical rebar slicing system for supplemental reinforcing bars.

Place deformed wire fabric in all vertical surface areas where the thickness of the shotcrete patch is greater than1 1/2 inches (38 mm) or bottom side of horizontal surfaces. Repairs areas on the top of horizontal surfaces do not require deformed wire fabric. Reinforce patches with deformed wire fabric meeting either 2 x 2 inches (50 x 50 mm) with wire size number D 0.9 (MD 6), or 3 x 3 inches (75 x 75 mm) with wire size number D 1.4 (MD 9). Cover the entire area of the repair with deformed wire fabric, place the wire fabric no closer than ½ inch (13mm) to the prepared surface and not less than 1 inch (25 mm) from the finished surface. Overlap adjacent sheets of deformed wire fabric by 6 inches (150 mm), and securely tie them together. Carefully pre-bend fabric before installation to fit around corners and into re-entrant angles. Rolled wire fabric is prohibited. Wire fabric held in place by elastic force (spring-loaded) or by friction is prohibited.

The deformed wire fabric can be tied to the existing reinforcing bars if there is a 3/4 inch (19 mm) clearance around the bar. The maximum anchor spacing for the

deformed wire fabric is 18 inches (46 cm) on center, in all horizontal for vertical surfaces and 12 inches (30 cm) in all horizontal for bottom vertical surfaces, overhead. A minimum of 3 anchors are required for each repair area. Unless specified on plans use 3/8 inch (10 mm) swedged anchor bolts. Embed anchors to manufactures recommendation to develop full capacity of swedge bolt. Use swedge bolt and nut to secure wire fabric.

520.10 Blast Cleaning of Repair Area. After performing 520.08 and 520.09, blast clean all surfaces to which shotcrete is to bond between 24 and 72 hours prior to placing of the shotcrete. All surfaces to which the concrete is to bond include exposed reinforcing steel, existing concrete, and the work face of any previously placed material. Blast clean all surfaces using high-pressure water blasting with or without abrasives in the water, abrasive blasting with containment, or vacuum abrasive blasting. High-pressure water washing requirements can be defined as a minimum pressure of 4000 psi (28 MPa) and flow of 5.0 gal/min (79 L/min). Maintain a standoff distance (the distance between the nozzle and the surface being cleaned) to a maximum of 12 in.

Bring the prepared substrate to saturated surface dry (SSD) with water meeting 520.02, ensure that all prepared substrate maintain a SSD prior to and during the shotcrete placement. The Engineer will approve the preparation and condition of all surfaces immediately before the application of the shotcrete..

520.11 Preconstruction Testing. Before placing any shotcrete on the project, each nozzleman will need to perform mock-up panels to be accepted by the Engineer. The purpose of the mock-up panel is to demonstrate the nozzleman's ability to place and finish shotcrete around the reinforcement. A nozzleman shall not perform any work on the structure until the Engineer accepts every mock-up panel.

Fabricate mock-up panels using the same personnel, equipment, materials and procedures that will be used on the project. Finish mock-up panels as required by plan, if no finish is required by plan, texture exposed surfaces according to 520.12.

Construct mock-up panels no less than 3 ft (0.9 m) square and a minimum of 4 inches (100 mm) deep. Mock-up panel depth will be adjusted if greater than 4 inches (100mm) to match the depth of application shown in the plans. Install reinforcement in the mock-up panel that matches the largest size and tightest spacing found for the reinforcement in the bridge. Orient the mock-up panel for a vertical surface application. If an overhead application is specified in the plan, perform an additional mock-up panel oriented for overhead application. Apply the shotcrete until panel is full and finish exposed surfaces. Age mock-up panels for at least 24 hours before cutting. Cut every mock-up panel in half, transverse to the main reinforcements. There shall be no voids with a maximum dimension greater than 0.25-inches adjacent to the reinforcement bars. If 0.25-inches or greater voids are found, an additional cut is to be performed to prove the debonding does not extend greater than 3-inches along the length of the reinforcement bar. The shotcrete in the mock-up panel shall not sag nor decrease the bond of the preceding coat for multiple layer application of shotcrete.

520.12 Shotcrete Placing. Place the shotcrete when the ambient temperature is between 50 °F and 90 °F. Do not place concrete against a surface containing frost, ice, standing water, or when the surface temperature is less than 40 °F. Protect the work from environmental conditions until final curing has been applied.

Do not place shotcrete during a rainfall event. Immediately cover previously placed shotcrete, not yet cured. Resume concrete placement after the rainfall stops.

Discontinue placement of shotcrete or shield the nozzle stream if wind causes separation of ingredients from the nozzle stream.

Apply the concrete using pneumatic equipment that sprays the mix onto the prepared surface. Minimize rebound and produce a compacted dense homogenous mass.

Use shooting strips or guide wires to ensure square corners, straight lines, and a plane surface of shotcrete, except as otherwise permitted by the plans or approved by the Engineer. Place shooting strips to keep the trapping of rebound at a minimum. At the end of each day's work, or similar stopping periods requiring construction joints, cut the work on a 45° angle through the full depth of the section, roughen the surface by stiff broom, racking or scoring for good surface bond when placing subsequent shotcrete layers. In shooting all surfaces, ensure that the stream of flowing material from the nozzle impinges as nearly as possible at right angles to the surface being covered, and hold the nozzle 2 to 4 feet (0.6 to 1.2 m) from the working surface.

Finish shotcrete repairs flush with the original masonry or concrete surface, except as noted for areas of exposed reinforcing steel. Do not initiate cutting or finishing until the shotcrete is sufficiently set. If not specified on plan, use rubber/sponge float to finish all exposed surfaces. On vertical and overhead surfaces, the layer thickness is to be establish and demonstrated during the preconstruction testing phase of the project. If a successive coat is applied on shotcrete that has set for more than 2 hours, clean and dampen the shotcrete surface as required in 520.05 for the prepared surface.

After shotcrete has been placed to the desired thickness, cut off all high spots with a sharp trowel, or screed them to a true plane as determined by shooting strips or by the original masonry surface, or as directed. If using screeds, apply them lightly to all surfaces so as not to disturb the shotcrete for an appreciable depth, and work them in an upward direction when applied on vertical surfaces.

Shotcrete rebounded outside of the formwork is prohibited from being worked back into the surface and is not to be salvaged and included in later batches. Rebounded shotcrete is the responsibly of the Contractor for removal and disposal.

520.13 Curing. Cover the pneumatically placed shotcrete patches with burlap or cotton mats and keep them wet for 7 days after placing. If it is not practical to use mats, keep the surface wet by sprinkling for the same length of time. If the Engineer determines that the above curing procedures are impractical because of the inaccessibility of isolated repair areas, the Contractor may cure the final shotcrete surface according to 511.14, Method B, using twice the manufacturer's recommended coating rate for formed concrete surfaces (equal to a white sheet of

typing paper) at the time of application. Protect all shotcrete against cold weather according to 511.12.

Do not use curing compounds on any surfaces against which additional shotcrete or other cementitious finishing materials are to be bonded unless positive measures, such as prepare surface per 520.10, are taken to completely remove curing compounds prior to application of such additional materials.

520.14 Inspection and Testing. At a minimum provide one test panel per nozzleman at the beginning of each day shotcreting occurs. The purpose of the test panel is to determine the compressive strength of all shotcrete placed after test panel per Table 520.3B-1. Fabricate test panel using the same personnel, equipment, materials and procedures that will be used on the project.

Construct a 24 inch x 24 inch x 3.5 inch (610mm x 610mm x 89mm) test panel with no reinforcement. Cure test panel in the same manner used for the structure. Follow ASTM C 1140 for panel size and coring, and compressive strength testing as per ASTM C 1604. Provide a minimum of six cores, test three cores per test age. Test the cores at an AASHTO Accredited laboratory for compressive strength.

After curing and before final acceptance, sound all patched areas. Remove and replace all unsound or cracked areas. In addition to sounding all patches, the Department will base acceptance of the shotcrete on compressive strength tests on cores taken from test panels.

Remove, replace, re-inspect, and re-test all defective patches, as determined by sounding, visible cracks, or unacceptable cores. Fill core holes according to 519.

Maintain the in-place inspection access equipment employed during the original work activities or provide alternate inspection equipment such as platform lifts, bucket trucks, snooper trucks, or equivalent as approved by the Engineer for testing.

520.15 Method of Measurement. The Department will measure Pneumatically Placed Shotcrete by the number of square feet (square meters). The Department will measure the area of exposed surfaces of all completed, tested, and approved patches, irrespective of depth or thickness of the patch. If a patch includes corners or edges of such members as beams, columns, or curbs, the Department will include all the exposed surfaces; if a patch extends completely through a member or a slab, the Department will include both exposed surfaces.

The Contractor is responsible for all test panels, coring repair of core holes, independent laboratory testing of the cores, replacement of rejected areas, and all previously mentioned work under Pneumatically Placed Shotcrete for payment.

520.16 Basis of Payment. The Department will not pay for additional reinforcement to replace that damaged by the Contractor's operations.

The Department will not pay for removing, replacing, and re-inspecting of defective patched shotcrete as determined by sounding, visible cracks, or unacceptable cores.

The Department will pay for accepted quantities at the contract price as follows:

TABLE 520.16-1 SHOTCRETE 28 DAY COMPRESSIVE STRENGTH PAY FACTOR

Compressive Strength (psi)	Pay Factor (%)
>4000	100
3999 –3700	90
3699 – 3520	75
<3520	Remove and Replace

Item	Unit	Description
520	Square Foot (Square Meter)	Pneumatically Placed Concrete Shotcrete

ITEM 522 STRUCTURAL PLATE CORRUGATED METAL STRUCTURES ON FOOTINGS

522.01 Description
522.02 Materials
522.03 General
522.04 Method of Measurement
522.05 Basis of Payment

522.01 Description. This work consists of furnishing structural plate corrugated metal structures of specified dimensions, including metal bearing angles or channels as required, and erecting same on concrete footings.

522.02 Materials. Furnish plates and bolts conforming to 707.03 or 707.23. Furnish steel bearing angles or channels conforming to 707.03 or 711.01. Furnish aluminum bearing angles or channels conforming to 707.23.

522.03 General. Properly support the metal bearing angle or channel in the position shown on the plans before placing footing concrete.

Erect the plates according to the manufacturer's assembly instructions. Hold the unsupported edges of all plates in position using temporary props. Progressively install a sufficient number of bolts to hold the plates in position. Do not tighten bolts until tightening will not interfere with the adjustment and matching of additional sections. If using drift pins or pry bars, take care to prevent chipping or injury to the galvanized coating. Tighten the bolts to a final minimum torque of 100 foot-pounds (140 Nm).

Within the limits of backfill, field coat the exterior of the 707.03 conduit above the limits of the bedding. The coating material and application shall conform to AASHTO M 243M. Thoroughly seal around all plate seams and bolts. Allow asphalt mastic material to dry for 48 hours and tar base material to dry for 28 hours before placing the conduit backfill.

Backfill according to the requirements for 611.

522.04 Method of Measurement. The Department will measure the actual number of feet (meters) of the corrugated metal structure, installed in place. The Department will determine the length by taking the average of the two side measurements, end to end, at the point of bearing.

Excavation will be paid for under Item 203 or 503 as shown on the plans.

Concrete footings will be paid for as a separate pay item.

522.05 Basis of Payment. The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
522	Foot (Meter)	___' ___" (___ mm) Structural Plate Corrugated Metal Structure, ___-inch (___ mm)

ITEM 523 DYNAMIC LOAD TEST

523.01 Description
523.02 General
523.03 Equipment
523.04 Test Report
523.05 Basis of Payment

523.01 Description. This work consists of establishing a driving criteria for all the piles of a specified shape, cross-section, and ultimate bearing capacity or as specified on the plans to be installed in the structure. This shall be accomplished by applying dynamic loads with a pile hammer during driving of production piles to determine driving requirements. Apply the dynamic load to the piles using a pile hammer that is operating at its normal operating level. Perform restrike tests when specified in the plans

523.02 General. Perform dynamic tests on two successfully tested piles. A successfully tested pile is one that provides adequate data to provide pile driving criteria as described in 523.04. Test the first two piles driven for each pile size and UBV combination defined in the Plans; the two piles tested should be the two piles furthest apart within the same substructure unit and phase. Perform signal matching analysis of the dynamic test data on at least one of the two test piles. Perform the test according to ASTM D 4945 to determine driving requirements to achieve the required ultimate bearing values for the piles to be installed in the structure.

Perform restrike tests after piles have been driven and a minimum time specified in the plans has elapsed. When performing a restrike, warm the hammer before restriking the pile by applying at least 20 blows to another pile. Each restrike consists of performing dynamic testing on two piles and performing a signal matching analysis on one of the two piles tested. Test the same two piles as were tested for the dynamic load test item.

Use the hammer selected for driving the test piles to drive all piles represented by the test piles. If the Contractor subsequently finds it necessary to use a different hammer or multiple hammers to drive piles represented by dynamic load testing, or

if the hammer performance varies subsequent to the dynamic test, complete additional tests at no additional cost to the Department.

523.03 Equipment. Supply all required dynamic testing equipment necessary to run the test set forth in ASTM D 4945. Supply personnel with an Advanced Master, or Expert Level Certification in High Strain Dynamic Pile Testing (HSDPT) from either Foundation QA or the Pile Driving Contractors Association (PDCA) to operate this equipment. Supply the Engineer a copy of the certificate showing that personnel operating dynamic testing equipment are currently certified. Supply all personnel and equipment needed to strike the test piles with the pile hammer.

523.04 Test Report. Perform the dynamic test and signal matching analysis and immediately provide the Engineer driving criteria for any piles to be driven within the next 48 hours. Within 48 hours after performing the dynamic pile test or restrike tests, supply the Engineer with a written report confirming driving requirements for piles represented by the test. Include in the report, the required blow count for:

A. The different strokes of the ram at 6 inch (150 mm) intervals within the expected range of operation as determined by a wave equation analysis, when open ended diesel hammers and drop hammers are used.

B. The selected bounce pressures when closed end diesel hammers are used.

C. The operating air pressure and stroke when an air operated hammer is used.

D. The selected output energy or stroke when a hydraulic hammer is used.

Also include in the report a minimum depth of penetration if applicable.

Submit an electronic version of the report and data files from the testing and analysis to the Office of Geotechnical Engineering and the Office of Construction Administration.

523.05 Basis of Payment. The Department will pay for dynamic load testing after being provided the written test at the contract price as follows:

Item	Unit	Description
523	Each	Dynamic Load Testing
523	Each	Restrike

ITEM 524 DRILLED SHAFTS

524.01 Description. This work consists of furnishing and installing drilled shafts. The lengths of the drilled shafts shown on the plans are estimated from available subsurface information. Furnish the proposed drilled shafts according to plan requirements, with the understanding that the actual length required is based on conditions encountered during construction and may differ from the estimated length shown on the plans.

524.02 Materials. Furnish material conforming to:

Concrete, Class QC 5 or QC 4
for Mass Concrete 499, 511
Epoxy coated reinforcing steel 509

524.03 Contractor's Installation Plan. Submit, for the Engineer's acceptance, a written installation plan of procedures to follow when excavating the hole, placing the concrete, and monitoring the concrete placement. Submit the installation plan at least 14 Calendar Days before constructing the drilled shafts. Include the following information:

A. Details of the sequence proposed for the overall drilled shaft construction operation.

B. Procedures for maintaining correct horizontal and vertical alignment of the excavation.

C. If using a casing, method to advance the casing.

D. If using a temporary casing, details of the methods to extract the temporary casing and to maintain the concrete slump to keep concrete workable by adding admixtures such as retarders or superplasticizers.

E. If using slurry, details of the methods to mix, circulate, and de-sand the slurry. For polymer slurry, submit the manufacturer's recommendations for use of the slurry.

F. Details of methods to clean the shaft excavation.

G. Details of reinforcement placement including support and centralization methods.

H. Details of concrete placement including proposed operational procedures for free fall, tremie, or pumping methods.

I. A list of proposed equipment to be used such as cranes, drills, augers, bailing buckets, final cleaning equipment, de-sanding equipment, slurry pumps, tremies, concrete pumps, casings, etc.

Acceptance of the installation plan will not relieve the Contractor of the responsibility for obtaining the required results.

524.04 Hole Excavation. Take precautions to prevent damaging existing structures and utilities. Precautions include, but are not limited to, selecting construction methods and procedures that will prevent excessive caving of the shaft excavation, and monitoring and controlling the vibrations from the driving of casing or sheeting or drilling of the shaft.

When encountered, remove objects such as large boulders. Do not blast unless shown on the plans or authorized in writing by the Engineer.

Unless otherwise shown on the plans, where drilled shafts are to be installed in conjunction with embankment placement, construct shafts after the placement of the fill and completion of any specified settlement periods.

Excavate for the shafts to the dimensions and elevations shown on the plans. Use methods and equipment suitable for the intended purpose and materials encountered. Use either the dry method, wet method, temporary casing method, or permanent casing method as necessary to produce sound, durable concrete foundation shafts free of defects. When a particular method of construction is required on the plans, that method shall be used. If no particular method is specified for use, select and use a method based on site conditions.

If the excavation operation is stopped, protect the shaft cavity by installing a safety cover. The Contractor is responsible for the safety of the shaft excavation, surrounding soil, and the stability of the sidewalls. If necessary to ensure such safety and stability, use a temporary casing, slurry, or other methods accepted by the Engineer. Unless cased to the full depth, do not leave excavations unfilled overnight.

Use appropriate means, such as a cleanout bucket or air lift, to clean the bottom of the excavation of all shafts. Promptly notify the Engineer when unexpected obstructions are encountered.

A. Dry Construction Method. Use the dry construction method only at sites where the groundwater table and site conditions are suitable to allow construction of the shaft in a relatively dry excavation, and where the sides and bottom of the shaft remain stable without any caving, sloughing, or swelling and may be visually inspected before placing the concrete. The dry method consists of excavating the drilled shaft hole, removing accumulated water, and loose material from the excavation, and placing the shaft concrete in a relatively dry excavation. The rate of flow of water into the hole should not be more than 12 inches (300 mm) within a 1-hour period. Do not place the initial concrete if there is more than 3 inches (75 mm) of water in the bottom of the hole.

B. Wet Construction Method. Use the wet construction method at sites where a dry excavation cannot be maintained for placement of the shaft concrete. The wet method consists of using water or slurry to contain seepage and groundwater movement and placing concrete using a tremie or concrete pump. Additionally, use this method to maintain stability of the hole perimeter while advancing the excavation to its final depth, placing the reinforcing cage, and placing the shaft concrete. This method also consists of de-sanding and cleaning the slurry. For drilled

shafts that are not socketed into the bedrock and during drilling operations, maintain a water or slurry fluid elevation inside the shaft excavation higher than the static water table. Unless demonstrated to the Engineer's satisfaction that the surface casing is not required, provide temporary surface casings to aid shaft alignment and position and to prevent sloughing of the top of the shaft excavation. Extend surface casings from the ground surface to a point in the shaft excavation where sloughing of the surrounding soil does not occur.

C. Temporary Casing Construction Method. Use the temporary casing construction method when the stability of the excavated hole and/or the effects of groundwater must be controlled. Remove temporary casings while the concrete remains workable. As the casing is being withdrawn, maintain a 5 foot (1.5 m) minimum head of fresh concrete in the casing so that all the fluid trapped behind the casing is displaced upward without contaminating the shaft concrete. As necessary, increase the required minimum concrete head to counteract groundwater head inside the casing. Extract casing at a slow, uniform rate with the pull in line with the shaft axis. Rotate, tap, push down, or vibrate the casing when necessary to extract it. Rotate the casing as little as possible to avoid deforming the reinforcing steel cage.

D. Permanent Casing Construction Method. The permanent casing construction method generally consists of driving or drilling a casing to a specified depth before excavation begins. If full penetration of the casing to the specified depth cannot be attained, the Contractor may either excavate material within the embedded portion of the casing or excavate a pilot hole ahead of the casing until the casing reaches the desired penetration. Make the pilot hole no larger than one-half the diameter of the shaft and center the hole in the shaft. Do not over ream to the outside diameter of the casing unless specifically shown on the plans.

Ensure that the casing is continuous between the elevations shown on the plans. Unless otherwise shown on the plans, do not use temporary casing instead of or in addition to the permanent casing.

After installing the casing and excavating the shaft, place the reinforcing steel, then place the shaft concrete. After filling the permanent casing with concrete, pressure grout voids between the shaft excavation and the casing with cement grout. Submit the method of pressure grouting the voids to the Engineer for approval. Pressure grouting is required to ensure contact (bearing) between the casing and any surrounding soil layer that is used for lateral support.

524.05 Friction Type Drilled Shafts. Friction type drilled shafts are defined as drilled shafts that do not bear on bedrock and obtain their ability to support load from a combination of end bearing on the soil and adhesion between soil and concrete along the length of the shaft.

For friction type drilled shafts, dry construction method may be used for cohesive soils only. If using a casing for the construction of a friction type drilled shaft, remove the casing completely or partially as shown on the plans. If enough water is entering the hole through the sides and bottom of the hole such that the supporting soils are being eroded, maintain a positive head of fluid in the excavation hole to ensure that water is not continuously flowing into the hole.

If the Engineer determines that the hole sidewall has softened due to excavation methods, swelled due to delays in concreting, or degraded because of slurry cake buildup, over ream the sidewall to sound material. If the concrete is not placed the same day that the excavation is completed, protect the excavation with a temporary casing, and redrill the hole at least 6 inches (150 mm) larger in diameter, clean the excavation, and perform slurry test before concreting.

524.06 Casings. Use smooth, watertight, steel casings of sufficient strength to withstand handling and driving stresses and the concrete and surrounding earth pressures. Provide an outside diameter of the steel casing equal to or greater than the plan diameter of the shaft. If the plan diameter of the bedrock socket is same as the drilled shaft above the bedrock and a steel casing is used, provide a diameter of the bedrock socket as shown on the plans. Ensure that the diameter of the casing is large enough to allow the excavation of the bedrock socket.

Where drilled shafts are located in open water areas, extend the casing a minimum of 12 inches (300 mm) above the water to protect the shaft concrete from water action during placement and curing of the concrete. Cut off the casing at the plan top of drilled shaft elevation after the concrete has cured. If practical, install the casing in a manner that produces a positive seal at the bottom of the casing to prevent piping of water or entry of other material into the shaft excavation.

If it becomes necessary to remove a casing and substitute a longer or larger diameter casing through caving soils, stabilize the excavation with slurry or backfill before installing the new casing. The Contractor may use other methods accepted by the Engineer to control the stability of the excavation and to protect the integrity of the foundation soils.

524.07 Slurry. Slurry used in the drilling process shall be a mineral or polymer slurry. The mineral slurry shall have both a mineral grain size that remains in suspension and sufficient viscosity and gel characteristics to transport excavated material to a suitable screening system. Ensure that the percentage and specific gravity of the material used to make the suspension is sufficient to maintain the stability of the excavation and to allow proper concrete placement. Maintain the level of the slurry at a height sufficient to prevent caving of the hole.

Thoroughly premix the mineral slurry with clean fresh water and allow adequate time for hydration before introduction into the shaft excavation. Agitate, circulate, and adjust the properties of the slurry to prevent the slurry from “setting up” in the shaft excavation.

Perform control tests using suitable apparatus on the mineral slurry to determine density, viscosity, and pH. Conform to the acceptable range of values for these physical properties as shown in Table 524.07-1.

TABLE 524.07-1 MINERAL SLURRY SPECIFICATIONS RANGE OF VALUES AT 68 °F (20 °C)

Property	Test Method	Time of Slurry Introduction	Time of Concreting in Hole
Density lb/ft³ (kg/m³)	Density Balance	64.3 to 69.1 (1030 to 1107)	64.3 to 75.0 (1030 to 1201)
Viscosity s/qt (s/L)	Marsh Cone	28 to 45 (30 to 48)	28 to 45 (30 to 48)
pH	pH Paper or meter	8 to 11	8 to 11

If de-sanding is required, do not allow the sand content to exceed 4 percent by volume at any point in the shaft excavation as determined by the American Petroleum Institute sand content test.

Determine density, viscosity, and pH values before and during the shaft excavation to establish a consistent working pattern.

Before placing shaft concrete, use an approved slurry-sampling tool to take slurry samples from the bottom and at mid-height of the shaft. Eliminate heavily contaminated slurry that has accumulated at the bottom of the shaft. Ensure that the mineral slurry conforms to the requirements specified immediately before shaft concrete placement.

Only use polymer slurry after demonstrating to the Engineer that the stability of the hole perimeter can be maintained while advancing the excavation to its final depth by excavating a trial hole of the same diameter and depth as that of the production shafts. Use the same polymer slurry in the trial hole as proposed for the production shafts. If using different sizes of the shafts at the project, use the same size trial hole as that of the largest diameter shaft, except the depth of the trial hole need not be more than 40 feet (12 meters). Only one trial hole per project is required. Do not use the trial hole excavation for a production shaft. After completing the trial hole excavation, fill the hole with sand. The acceptance of the polymer slurry does not relieve the Contractor of responsibility to maintain the stability of the excavation. Polymer slurry shall conform to the manufacturer's requirements.

524.08 Excavation Inspection. Provide equipment for checking the dimensions and alignment of each shaft excavation. Determine the dimensions and alignment. Measure the final shaft depth after final inspection.

Immediately before placing concrete, ensure that the bottom of the completed drilled shaft excavation is as clean as practical. Remove drilling spoils that adhere to the vertical sides of the bedrock socket.

524.09 Reinforcing Steel for Drilled Shafts. Place the reinforcing steel cage as a unit immediately after inspection of the excavation and before placing concrete. If not placing the concrete immediately after installing the cage, the Contractor may have to remove the cage before placing the concrete to verify the integrity of the excavated area and to ensure loose material is removed from the bottom of the hole.

Tie and support the reinforcing steel so it remains within the required tolerances. Securely tie spacers at quarter points around the cage perimeter and space at intervals not to exceed 5 feet (1.5 m) along the length of the cage. If the size of the

longitudinal reinforcing steel equals or exceeds 1 inch (25 mm) in diameter, the Contractor may increase the distance between the spacing devices to a maximum of 10 feet (3 m). Use spacers of adequate dimensions to ensure a minimum annular space between outside of cage and side of hole or casing of 3 inches (75 mm) for shaft diameters up to 4 feet (1.2 m) and 6 inches (150 mm) for shaft diameters larger than 4 feet (1.2 m). The Contractor may use round plastic spacers.

Maintain the top of the reinforcing steel cage no more than 6 inches (150 mm) above and no more than 3 inches (75 mm) below the required position. If the reinforcing steel cage is not maintained within tolerances, make acceptable corrections and do not construct additional shafts until the method of reinforcing steel cage support has been approved.

When approved by the Engineer, the Contractor need not provide the reinforcing steel for the extended length of the drilled shaft if it is determined in the field that the Contractor must drill the shaft deeper than the estimated length.

524.10 Concrete for Drilled Shafts. For all drilled shafts, use Class QC 5 or QC 4 concrete for Mass Concrete,(drilled shaft diameter over 7 ft (2.1 m), according to Item 511 except as modified and supplemented as follows. The required slump is 6 ± 1 inch (150 ± 25 mm). Achieve the additional slump over 4 inches (100 mm) by using chemical admixtures conforming to 705.12, Type F or G. The maximum water-cement ratio shall not exceed 0.44. If placing concrete under water, add 10 percent more cement to the concrete mix. If placing concrete using a tremie, further increase the slump to 8 ± 1 inch (200 ± 25 mm), by using chemical admixtures.

For wet method construction, place concrete in one continuous operation from bottom to top of the shaft. After the concrete has reached the top of the drilled shaft, continue pumping and remove all contaminated concrete until acceptable quality concrete is evident at the top of the shaft. Do not vibrate concrete with a vibrator. Carefully remove the casing so that the reinforcing steel cage is not deformed by the force of the downward flowing concrete.

Do not place concrete in any drilled shaft excavation without acceptance from the Engineer. Inspect the drilled shaft excavation immediately before placing the concrete. Provide a light powerful enough to thoroughly inspect the reinforcing steel cage, the sides, and the bottom of the drilled shaft. The inspection for the wet construction method consists of only probing and measuring.

If the elevation of the top of the shaft is below ground at the time of concrete placement, use a casing to prevent caving of materials into fresh concrete.

524.11 Free Fall Concrete Placement. The Contractor may place the concrete in a dry drilled shaft excavation using the free fall method provided the concrete falls to its final position through air without striking the sides of the hole, the reinforcing steel cage, or any other obstruction. Use a centering drop chute, at least 3 feet (1 m) long with the free fall method. Unless shown on the plans, there is no limit to the height of free fall. If the concrete placement causes the shaft excavation to cave or slough or if the concrete strikes the rebar cage or sidewall, reduce the height of free fall or the rate of concrete flow into the excavation, or both.

If the Engineer determines that dewatering is not practical or placement by free fall method cannot be accomplished, place the concrete using a tremie or a concrete pump.

524.12 Tremie. The Contractor may use a gravity tremie to place concrete placement instead of a concrete pump in either wet or dry holes. For uncased wet holes, maintain the drilled shaft excavation full of slurry or water to such a depth that water does not flow into the shaft excavation at any time. To place concrete, use tremies consisting of a tube of sufficient length, weight, and diameter to discharge concrete at the shaft base elevation. If the tremie contains aluminum parts, do not allow these parts to contact the concrete. Use tremies with an inside diameter of at least 10 inches (250 mm). Ensure that the inside and outside surfaces of the tremie are clean and smooth to allow both flow of concrete and unimpeded withdrawal during concreting. Use tremies with a wall thickness adequate to prevent crimping or sharp bends that restrict concrete placement.

For concrete placement, use water-tight tremies. Do not begin underwater placement until the tremie is placed to the shaft bottom elevation. Use valves, bottom plates, or plugs so concrete discharge can begin within one tremie diameter of the base. Either remove plugs from the excavation or use plugs of an Engineer approved material that does not cause a defect in the shaft if not removed. Construct the discharge end of the tremie to allow the free radial flow of concrete during placement operations. Immerse the tremie discharge end at least 10 feet (3 m) in concrete at all times after starting the flow of concrete.

If the tremie line orifice is removed from the fluid concrete column during the concrete pour, and discharges concrete above the rising concrete level, consider the drilled shaft defective.

524.13 Pumped Concrete. Pump concrete into either wet or dry holes. For uncased wet holes, maintain the drilled shaft excavation full of slurry or water to such a depth that water does not flow into the shaft excavation at any time. Use concrete pump pipe at least 4 inches (100 mm) in diameter and constructed with watertight joints. Arrange the concrete pump equipment so no vibrations result that might damage fresh concrete. Arrange pipes carrying concrete from the pump to the shaft with a minimum number of bends. Anchor the pipe used to convey the concrete to the bottom of the drilled shaft excavation to the steel casing or another suitable stationary object to prevent the pipe from undulating during the initial placement of the concrete. Do not begin placing concrete until the pump line orifice is at the shaft base elevation.

Do not use aluminum pipe as a conveyance for the concrete. Pump an adequate quantity of grout, mortar, or concrete without coarse aggregate through the equipment ahead of the specification concrete to provide lubrication to the pumping system. Do not place the concrete used for lubrication in the shaft. The lubrication process will not be repeated as long as the pumping operations are continuous. Operate the pump so a continuous stream of concrete without air pockets is produced. To prevent the contamination of the concrete placed initially at the bottom of the shaft, seal the outlet end of the pumping pipe with a diaphragm or plug that is flushed out when the hydrostatic pressure from the column of concrete exceeds that of the water in the shaft. Control the initial rate of concrete placement so not to lift

or displace the cage of reinforcing steel. Use a watertight conveying system, and leave the outlet end well below the top of the freshly placed concrete. The preferred concrete placement procedure is to maintain the outlet end of the pumping system at approximately 10 feet (3 m) below the top of the fresh concrete. When the concrete reaches the top of the drilled shaft column, remove all laitance.

If the concrete pump line orifice is removed from the fluid concrete column during the concrete pour, and discharges concrete above the rising concrete level, the drilled shaft shall be considered defective.

524.14 Construction Tolerances. For shafts supporting single columns, position the drilled shaft within 3 inches (75 mm) of the plan location in the horizontal plane at the plan elevation for the top of the shaft. For shafts supporting footings, position the center within 6 inches (150 mm) of the plan location. Do not allow the vertical alignment of the shaft to vary from the required alignment by more than 1/4 inch per foot (21 mm/m) of depth. Construct the supported elements at the plan location. Perform all corrections required to construct the supported elements.

524.15 Inspection Records. Provide all necessary equipment and labor needed to obtain measurements for completing the Inspection Records. Obtain measurements before placing concrete.

524.16 Method of Measurement. The Department will measure Drilled Shafts by the number of feet (meters), measured along the axis of the drilled shaft from the required bottom elevation of the shaft to the proposed top plan elevation. The Department will not measure the length of reinforcing steel projecting from the drilled shaft into the pier column or the footing supported on Drilled Shafts as shown on the plans. If the drilled shaft extends into the bedrock, The Department will divide the total length of each drilled shaft into two segments. The length of the lower segment is the length of the bedrock socket, and the length of the upper segment is the length of the drilled shaft above the bedrock socket.

If a steel casing extending down to bedrock is used, the Department will measure the bedrock socket from the bottom of the casing to the bottom of the drilled bedrock excavation. If the Engineer is assured that a portion of the metal casing is embedded in solid bedrock, and upon the Engineer's concurrence, the Department may include the embedded distance as a part of the bedrock socket.

524.17 Basis of Payment. Payment is full compensation for performing required excavation; furnishing and placing steel casings; furnishing and placing reinforcing steel and concrete by free fall, pumping, or tremie method; removing casings; casings left in place; supplying equipment and performing slurry testing; supplying and disposing of slurry; and disposing excess excavated material.

The Department will not pay for the cost of performing slurry tests before concreting.

The Department will not make separate payment for the trial holes.

The Department will not pay for corrections required to construct the supported elements.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
524	Foot (Meter)	Drilled Shafts, ___" (___ mm) Diameter, above Bedrock
524	Foot (Meter)	Drilled Shafts, ___" (___ mm) Diameter, into Bedrock
524	Foot (Meter)	Drilled Shafts, ___" (___ mm) Diameter

ITEM 526 APPROACH SLABS

526.01 Description. This work consists of constructing reinforced portland cement concrete approach slabs for bridges on the completed and accepted subgrade or subbase.

526.02 Materials. Furnish materials conforming to:

Concrete, Class QC 2* 499
Epoxy coated reinforcing steel..... 509.02, 709.00
Preformed joint filler..... 705.03
Joint sealer..... 705.04 or 705.11

* Use the same class of concrete used in the bridges superstructure that the approach slab is attached to unless otherwise shown in the plans. If the super-structure concrete class for the bridge is not identified in the plans use Class QC 2.

526.03 Forming, Furnishing and Placing Reinforcing Steel. Furnish true and straight steel or wooden side forms. Securely brace and hold forms to the line and grade shown on the plans. Do not allow forms to vary more than 1/8 inch (3 mm) from a 10 foot (3 m) straightedge. Do not remove forms for a minimum of 36 hours. Clean and oil forms after each use.

Furnish reinforcing steel and place it in the position shown on the standard construction drawing and firmly secure the steel during placing and setting of the concrete. Tie reinforcing bars at all intersections, except tie reinforcing bars at alternate intersections where bar spacing is less than 1 foot (0.3 m) in any direction.

526.04 Placing and Sampling Concrete. Immediately before placing concrete according to Item 511. 07, thoroughly moisten the subgrade or subbase with water in the amount and manner directed by the Engineer. When the bridge superstructure and the approach slab require QC/QA, make at least one set of test cylinders for each

50 cubic yards (35 cubic meters) of concrete. Include the results of the cylinders into the Lot for the 511 superstructure item.

526.05 Finishing and Curing. Mechanically screed, at a vibration frequency of 1500 to 5000 pulses per minute, the concrete surface to the proper elevation in one complete pass with a minimum of hand finishing. Cure approach slabs according to 511.14.A. Seal joints and cracks according to 511.19. If the approach slab is to serve as a base for an asphalt concrete wearing course, texture the approach slab according to Item 305. If the approach slab is to serve as a wearing surface, test the surface according to 451.13, and diamond groove the surface according to 511.17.

Open approach slabs to traffic according to Table 511.14-1A or Table 511.14-1B.

526.06 Side Curbs. If concrete curb extends across the approach slab, construct side curbs of the dimensions required, and place the concrete curb at the same time as the approach slab. Finish the curb according to Item 609.

526.07 Method of Measurement. The Department will measure Reinforced Concrete Approach Slabs by the number of square yards (square meters) complete in place.

526.08 Basis of Payment. The Department will calculate the final adjusted payment per 511 and Supplement 1127. The Department will pay for accepted quantities at the contract price as follows which includes all concrete, curbs, reinforcing steel, dowels, joints and other materials:

Item	Unit	Description
526	Square Yard (Square Meter)	Reinforced Concrete Approach Slabs
526	Square Yard (Square Meter)	Reinforced Concrete Approach Slabs with QC/QA

600 INCIDENTALS

ITEM 601 SLOPE AND CHANNEL PROTECTION

601.01 Description. This work consists of the excavation for and the construction of gutters, riprap, concrete, grouted items, tied concrete block mats, articulating concrete block revetment systems, crushed aggregate, or rock items for protecting slopes and channels.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

601.02 Materials. Furnish materials conforming to:

Curing	451 or 705.07 Type 1
Concrete, Class QC-Misc	499, 511
Water for grout	499.02
Reinforcing steel	509.02
Cement for grout	701
Structural Backfill Type 3	703.11
Sand for grout	703.03
Rock and Aggregate Materials	703.19
Coarse Aggregate	703.20
Brick and blocks	704
Preformed expansion joint	705.03
Joint sealer	705.04
Geotextile Fabric, Type B	712.09

Provide steel Geotextile Fabric securing pins with washers for securing Geotextile Fabric. Use a steel washer having an outside diameter not less than 1 1/2 inches (38 mm). Use securing pins at least 18 inches (0.5 m) long and at least 3/16

inch (5 mm) in diameter that are pointed at one end and fabricated with a head to retain the steel washer.

Ensure tied concrete block mats and articulating concrete block revetment systems are held together by galvanized steel wire, HDPE mesh, polypropylene mesh, or stainless steel wire.

601.03 General Construction. Cure gutters, concrete slope protection, and grouted riprap according to Item 451, except apply all the membrane cures at the rate of not less than 1 gallon per 200 square feet (1 L/5 m²) of surface.

Mix and place all concrete according to Item 511. Finish to produce a sandy texture.

601.04 Riprap. Construct riprap according to one of the following four alternatives unless specifically itemized in the Contract. The Contractor may elect to use a different alternative at each location on the project.

A. Type A - Provide Flat Stones or Broken Concrete. Ensure that individual pieces are roughly rectangular in cross-section with a minimum volume of 1/3 cubic foot (0.01 m³) and a minimum thickness of 3 inches (75 mm). Place individual pieces by hand in courses and so that the pieces overlap the joints in the course below. Place riprap with the flat surfaces roughly perpendicular to the slope and in contact with the courses immediately below and above. Fill spaces between larger pieces with spalls that are rammed into place to present an even and tight surface, pleasing in appearance and varying not more than 3 inches (75 mm) from that shown on the plans. When required by the plans, fill riprap with grout. Compact the backing as riprap construction progresses. Ensure that the thickness of the riprap, measured perpendicular to the slope, is not flatter than 9 inches (230 mm) and averages not flatter than 12 inches (0.3 m).

B. Type B - Provide Articulating Concrete Block Revetment System. Ensure articulating concrete block revetment conform to 712.13. Install according to the manufacturer's recommendations.

C. Type C - Construct Concrete Riprap Using Cloth or Burlap Bags. After soaking the bags with water, fill them with approximately 2/3 cubic foot (0.02 m³) of concrete and place the bags by hand to the limits on the plans. Provide bags with approximate dimensions of 6 × 12 × 16 inches (150 × 300 × 400 mm).

Stack the bags on the slope to ensure a minimum of 1/3 cubic yard (0.3 m³) of concrete for each square yard (square meter) of riprap in place as measured along the slope.

Tie the open end of each bag and fold the tie under the bag. Place each tie or fold so that it overlaps the joint in the lower layer. After placing, pierce each bag in the lower layer to allow some concrete to flow out and bond with the top overlying layer.

Stretchers are bags placed with the long length parallel to the streambed flow. Headers are bags placed with the long length perpendicular to the streambed flow. A layer runs horizontally at approximately the same elevation perpendicular to the protected slope grade.

If the slope is 1.5:1 or steeper, make the bottom layer with two bags laid as stretchers. Place the next overlying layer as a header. Place the rest of the overlying upslope layers as stretchers.

If the slope is flatter than 1.5:1, make the bottom layer with two bags as stretchers. Place all remaining layers as headers.

Push or drive No. 4 (No. 13M) reinforcing bars approximately 18 inches (0.5 m) long and spaced approximately 12 inches (0.3 m) apart through the top three layers. When required by the plans, fill voids with grout.

D. Type D - Construct a 6-inch (150 mm) Reinforced Concrete Slab. Reinforce the slab approximately midway between the top and bottom of the slab with steel bars or fabricated reinforcement equivalent to No. 3 (No. 10M) round bars, spaced at 24 inch (0.6 m) centers in two directions, or wire fabric according to the standard construction drawing for pavement reinforcing. The Contractor may use formed construction joints. Extend reinforcement through all formed construction joints. Include cutoff walls as shown on the plans in the unit price bid for reinforced concrete slab.

601.05 Grouted Riprap or Rock. When specified, grout in place riprap cloth bags, riprap burlap bags, flat stones, precast blocks, broken concrete, rock, or tied concrete block mats. Make the grout by mixing one part portland cement, three parts sand, and enough water to allow the grout to flow into the joints and cracks.

Prepare the grout in a mixing machine of an approved design and equipped with an accurate graduated regulating device for controlling the amount of water in each batch. Accurately measure and proportion the quantities for each batch, and ensure that the quantities are exactly sufficient for one or more sacks of cement.

Immediately before applying grout, thoroughly wet all surfaces. Place the grout, filling all the joints or voids. Do not add water to the grout after it has been placed.

601.06 Crushed Aggregate Slope Protection. Furnish material conforming to 703.19. Place the material on the Geotextile Fabric so that the surface is flush with the embankment slopes. Use a thickness of 12 inches (300 mm) unless a different thickness is specified. Extend the aggregate from the face of the abutments down to the toe of the slope or to normal water elevation, and a minimum of 3 feet (1 m) beyond the outer edges of the superstructures or as shown on the plans.

601.07 Concrete Slope Protection. Construct a concrete slab, 6 inches (150 mm) thick, extending over the embankment area under a bridge from the face of the abutment down to the toe of the slope and extending a minimum of 3 feet (1 m) beyond the outer edges of the superstructure or as shown on the plans. Thicken the bottom 3 feet (1 m) of the concrete slab from 6 to 18 inches (150 to 460 mm) to provide resistance to sliding.

Where pier columns extend through the slab, place 1 inch (25 mm) preformed expansion joint material around the columns and for the full thickness of the slab.

Divide the surface into an equally spaced block grid pattern at approximately 4 to 5 foot (1.2 to 1.5 m) intervals. Make the block grid pattern with one direction horizontally at a constant elevation or as directed by the Engineer, and the other direction parallel to the superstructure centerline, skewed, or as directed by the

Engineer. Saw or form the block grid pattern to make joints at a depth of not less than one-fourth the thickness of the slab and approximately 1/8 inch (3 mm) wide.

601.08 Dumped Rock Fill. Furnish material conforming to 703.19. Dump larger pieces at the outer face and smaller pieces in the inner surface of the protected area. Ensure a reasonably smooth and continuous surface conforming to the slope lines shown on the plans. Avoid concentration of fines and small pieces at any location in the completed dumped rock fill material. When required by the plans fill all voids with grout.

601.09 Rock Channel Protection. Furnish material conforming to 703.19. When specified with a filter, provide a filter consisting of Geotextile Fabric or a 6-inch (150 mm) bed of aggregate conforming to 703.19. When placing rock, exercise reasonable care to ensure that the finished surface of the protected channel conforms to the channel cross-sections shown on the plans.

If Geotextile Fabric is used, prepare the surface to receive the fabric to a relatively smooth surface, free of obstruction and debris. With the long dimension parallel to the flow direction, loosely place the fabric without wrinkles and creases. Where joints are necessary, provide a 12 inch (0.3 m) minimum overlap, with the upstream strip overlapping the downstream strip. Place securing pins with washers at a minimum distance apart of 2 feet (0.6 m) along the joints and at a minimum distance apart of 5 feet (1.5 m) everywhere else. When required by the plans fill all voids with grout.

601.10 Detention Basin Filter, Infiltration Basin Filter, Infiltration Trench Filter or Bioretention Cell. For Infiltration Basin Filter furnish course aggregate No. 57 or 67 conforming to 703.20. Use a thickness of 6 inches (150 mm) unless a different thickness is specified. Place the material on the geotextile fabric so that the surface is flush with the elevation as specified. Prepare the surface to receive the geotextile fabric to a relatively smooth surface, free of obstruction and debris. With the long dimension parallel to the flow direction, loosely place the geotextile fabric without wrinkles and creases. Where joints are necessary, provide a 12 inch (0.3 m) minimum overlap, with the upstream strip overlapping the downstream strip. Place securing pins with washers at a minimum distance apart of 2 feet (0.6 m) along the joints and at a minimum distance apart of 5 feet (1.5 m) everywhere else.

For Infiltration Trench Filter furnish course aggregate No. 1 or 2 conforming to 703.20. Place infiltration trench aggregate No. 1 or 2 on the geotextile fabric at the thickness specified. Prepare the surface to receive the geotextile fabric to be relatively smooth, free of obstruction and debris. With the long dimension parallel to the flow direction, loosely place the fabric without wrinkles and creases. Where joints are necessary, provide a 12-inch (0.3 m) minimum overlap, with the upstream strip overlapping the downstream strip. Place securing pins with washers at a minimum distance apart of 2 feet (0.6 m) along the joints and at a minimum distance apart of 5 feet (1.5 m) everywhere else.

For Bioretention Cell furnish material as specified at the thickness specified.

601.11 Paved Gutter. Mix and place concrete paved gutters according to Items 499 and 511 and to the dimensions and shape shown on the plans or the standard construction drawing.

When gutter constructed under this item is to be tied to an existing concrete base, pavement, or other rigid structure, match the type and location of the joints in the gutter with those in the adjoining pavement.

When gutter constructed under this item is not tied to an existing concrete base, form impressed joints using a device or bar shaped to the gutter cross-section. Make the impression before initial setting of the newly placed concrete. Remove the device or bar as soon as the concrete is in such condition to retain its shape when the bar or device is removed. Form an impressed joint that is 3/8 inch (10 mm) wide at the surface; 1/4 inch (6 mm) wide at the bottom; and a depth equal to one-third the thickness of the concrete. Edge the joints to a radius not greater than 1/4 inch (6 mm). Until the filler is placed, protect the joint from dirt or foreign matter. Fill the impressed joints in such a manner to confine the material to the joint and in no way mar the surface.

Compact the subgrade for all paved gutters according to 204.03. When required by the plans fill all voids with grout.

601.12 Tied Concrete Block Mat. When specified, use Tied Concrete Block Mat with Type ___ Underlayment conforming to 712.12 as shown on the plans. Install per the manufacturer's recommendation.

601.13 Articulating Concrete Block Revetment System. When specified, use Articulating Concrete Block Revetment System Type ( )_conforming to 712.13 as shown on the plans. Install per the manufacturer's recommendation.

601.14 Method of Measurement. The Department will measure Riprap, Articulating Concrete Block Revetment System, Crushed Aggregate Slope Protection, Concrete Slope Protection, and Tied Concrete Block Mats by the square yard (square meter) of the finished surface completed and accepted in place, with or without grout.

The Department will measure Dumped Rock Fill and Rock Channel Protection (with or without filter), by the cubic yard (cubic meter), completed and accepted in place according to the dimensions shown on the plans, excluding rock filter, with or without grout. The Department may determine quantities by volume in the vehicle or by a job conversion weight of acceptable material delivered.

The Department will measure Paved Gutter by the foot (meter) completed and accepted in place.

601.15 Basis of Payment. The Department will specify with grout in the pay item description when required. When the pay item calls out Tied Concrete Block Mat or Articulating Concrete Block Revetment System, include Geotextile Fabric material and installation in the price.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
601	Square Yard (Square Meter)	Riprap
601	Square Yard (Square Meter)	Crushed Aggregate Slope Protection

601	Square Yard (Square Meter)	Concrete Slope Protection
601	Square Yard (Square Meter)	Tied Concrete Block Mat with Type ___Underlayment
601	Square Yard (Square Meter)	Articulating Concrete Block Revetment System, Type___
601	Cubic Yard (Cubic Meter)	Dumped Rock Fill, Type ___
601	Cubic Yard (Cubic Meter)	Rock Channel Protection, Type ___ with Filter
601	Cubic Yard (Cubic Meter)	Rock Channel Protection, Type ___ without Filter
601	Cubic Yard (Cubic Meter)	Rock Channel Protection, Type ___ with Aggregate Filter
601	Square Yard (Square Meter)	Detention Basin Filter
601	Square Yard (Square Meter)	Infiltration Basin Filter
601	Square Yard (Square Meter)	Infiltration Trench Filter
601	Cubic Yard (Cubic Meter)	Bioretention Cell
601	Foot (Meter)	Paved Gutter

ITEM 602 MASONRY

602.01 Description. This work consists of constructing headwalls, pipe cradles, collars, and other brick and masonry units of the types and sizes specified.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

602.02 Materials. Furnish materials conforming to:

Backfill 203
Concrete, Class QC1 ..... 499 and 511
Water for grout and mortar 499.02
Reinforcing steel 509.02
Cement for mortar ..... 701.01 through 701.07
Sand for mortar 703.03
Granular base ..... Granular material, Type B, 703.16.C
Brick and masonry units 704.01, 704.02, 704.03
Nonshrink mortar 705.22
Lime for mortar. 712.04

602.03 Construction Requirements. Construct the designated items as shown on the plans.

A. Excavate to dimensions that provide ample room for construction. Remove obstructions as necessary to perform this work.

Protect the sides of all excavations from caving by providing suitable sheeting, shoring, and bracing. Use excavation methods that do not disturb the original material below the bottom of footers or below the additional 6 inches (150 mm) required for precast structures.

If the material found at the bottom of the headwall or below the additional 6 inches (150 mm) required for precast structures is not suitable for a foundation, excavate to further depth to provide a suitable foundation. Backfill the void left by the additional excavation with granular base. The Department will pay for this additional work according to 109.05.

Backfilling shall follow completion of the work as closely as the construction will allow. Backfill with granular base or soil. Place backfill in 6-inch (150 mm) loose lifts.

B. Compaction requirements are according to Item 203 except for the following:

Four passes per lift with additional passes as required until 95 percent compaction is reached. Use compaction equipment with a minimum total weight of, or minimum centrifugal force of, 1 ton (0.9 metric ton). Supply the manufacturer's specifications for this equipment to verify these requirements.

C. Cast-in-place structures are headwalls, wingwalls, pipe cradles, collars, and other units. Construct cast-in-place structures according to the corresponding Standard Construction Drawing using methods specified in Items 499, 511, and 509.

D. Precast structures for half height headwalls are for circular conduits up to a maximum of 78 inches (1980mm) and elliptical and pipe arch conduits up to a maximum 78 inches (1980 mm) round equivalent. The shop drawings are kept on file at the certified precast facility per Supplemental 1073. Construct elliptical and pipe arch half height headwalls from templates of the actual conduit being supplied to the project to ensure the opening is outside diameter plus one inch. Ensure the precast structures and their shop drawings conform to the following additional requirements:

1. All manufacturers are pre-approved according to Supplement 1073.

2. All reinforcing steel will be epoxy coated.

3. All HW-2.1 SCD require wire insert details.

4. Attachment detail for metal or plastic conduit conforming to SCD HW2.1.

5. Non-corrosive lifting devices.

6. Maximum opening is conduit outside diameter plus 1 inch (25 mm) for each conduit material type.

7. All openings to be filled with nonshrink mortar including all lifting device voids.

8. Changes in pre-approved drawings are the same as non pre-approved drawings.

9. Detail how the 6 inch (150 mm) extension is treated if required.

10. Fill the void between the precast half height headwall and the conduit by using nonshrink mortar.

11. Apply marking, either stamped or painted, to the headwall to ensure each headwall size is matched to the proper conduit size and material type.

E. Masonry units structures are headwalls, pipe cradles, collars, and other units. Thoroughly wet masonry units before laying the mortar. Lay masonry units with full mortar joints. Take adequate precautions to prevent the mortar from freezing. Do not set masonry units having a temperature of 40 °F (4 °C) or less with mortar until heated. When required, heat to ensure that a temperature of 50 to 80 °F (10 to 27 °C) is obtained throughout the entire masonry units. Cure the exposed surfaces of the masonry units by covering with wet burlap for 48 hours or by applying curing membrane according to Item 511. Construct the masonry units structures according to the corresponding Standard Construction Drawing. Use one of the following mortars:

1. One part Portland cement to two parts sand by volume. The Contractor may add lime in an amount not to exceed 10 percent of the cement by weight

2. One part masonry cement to two parts sand by volume.

602.04 Method of Measurement. The Department will measure Brick Masonry, Block Masonry, and Concrete Masonry by the number of cubic yards (cubic meters) calculated from dimensions shown on the plans.

602.05 Basis of Payment. When a precast structure is used, payment is based on the number of cubic yards (cubic meters) required for the cast in place item and is considered full compensation for construction of the precast structure.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
602	Cubic Yard (Cubic Meter)	Brick Masonry
602	Cubic Yard (Cubic Meter)	Block Masonry
602	Cubic Yard (Cubic Meter)	Concrete Masonry

ITEM 605 UNDERDRAINS

605.01 Description. This work consists of excavating, installing, and backfilling unclassified pipe underdrains, shallow pipe underdrains, deep pipe underdrains, base pipe underdrains, or rock cut underdrains with or without a Geotextile Fabric, construction underdrains, prefabricated edge underdrains and aggregate drains.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

605.02 Materials.

Concrete, Class QC-Misc ..... 499 and 511
Reinforcing steel 509.02
Geotextile Fabric, Type A 712.09

Backfill unclassified pipe underdrains, shallow pipe underdrains, deep pipe underdrains, base pipe underdrains, rock cut underdrains, with or without a Geotextile Fabric, construction underdrains and aggregate drains with granular material consisting of ACBFS, limestone, or gravel. Furnish granular material meeting Size Nos. 8, 9, or 89. Gradations may be modified in accordance with Supplement 1069.11.C. Use granular material with a maximum sodium sulfate soundness loss of 15 percent.

Backfill prefabricated edge underdrains with granular material consisting of No. 8 size air-cooled blast furnace slag, limestone, or gravel. Use granular material with a maximum sodium sulfate soundness loss of 15 percent.

For 605.02**.**A through 605.02.B, use the pipe of the same size and kind listed in the Proposal. If the kind of pipe is not specifically itemized in the Proposal, use types as listed below.

A. Pipe for 605 Rock Cut Underdrains.

Corrugated polyethylene drainage tubing
(perforated) 707.31
Smooth-wall polyvinyl chloride underdrain
Pipe 707.41
Polyvinyl chloride corrugated
smooth interior pipe
(perforated according to 707.31) 707.42
Polyvinyl chloride solid wall pipe

(perforated according to 707.31) 707.45

B. Pipe for 605 Unclassified Pipe Underdrains, Shallow Pipe Underdrains, Deep Pipe Underdrains, Base Pipe Underdrains

Perforated concrete pipe 706.06
Concrete drain tile, extra quality 706.07
Perforated vitrified clay pipe 706.08
Clay drain tile, extra quality 706.09
Corrugated steel underdrains, Type III 707.01
Corrugated polyethylene
drainage tubing, (perforated) 707.31
Polyvinyl chloride plastic pipe 707.41
Corrugated aluminum alloy pipe and
underdrains, Type III 707.21

C. Pipe for 605 Construction Underdrains

6 inch (150 mm) Corrugated polyethylene drainage
tubing (perforated) 707.31

D. Pipe for 605 Prefabricated Edge Underdrains. Use pipe conforming to 712.10.

605.03 Pipe Underdrains Construction. Construct underdrains as follows:

A. Excavation. Excavate trenches to such dimensions allowing ample room for construction. Construct the trench width to at least 14 inches (350 mm) for 6-inch (150 mm) diameter underdrains, and to at least 10 inches (250 mm) for 4-inch (100 mm) diameter underdrains. Excavate the trench walls as vertical as possible, and excavate bell holes to allow proper placing of the underdrain. Remove obstructions encountered while excavating for the underdrains.

Excavate trenches measured vertically from the subgrade to the bottom of the trench at a depth of 18 inches (450 mm) for base pipe underdrains, 30 inches (760 mm) for shallow pipe underdrains, and 50 inches (1270 mm) for deep pipe underdrains unless otherwise specified in the plans. Furnish a depth of 30 inches (760 mm) for construction underdrains unless otherwise specified in the plans. Excavate trenches for unclassified pipe underdrains to the depth specified in the plans.

Excavate trenches to a depth of 6 inches (150 mm) below the rock, shale or coal depth required in 204.05 for Rock Cut underdrains unless otherwise specified in the plans.

If underdrains are to be placed within or beneath an embankment, construct the embankment to the elevation of the top of the subgrade before trenching for the underdrain.

If fabric is specified, line the underdrain trench with Geotextile Fabric. Place the Geotextile Fabric to completely surround the granular material. Overlap the Geotextile Fabric at the top of the trench. Match the overlap to the trench width. At other seams, overlap Geotextile Fabric a minimum of 12 inches (0.3 m).

B. Laying Underdrain. Lay the underdrain true to line and grade with close fitting joints. Place the underdrain in the center of the trench . Use locking bands or smooth sleeve type couplers matching the underdrain material type to join 707.01, 707.31, 707.41, and 707.21. When bell and spigot underdrain is used, lay it with the bell end facing up grade. Set the underdrain on a solid bed shaped to fit the underdrain throughout its entire length. Make all necessary connections with branches, wyes, tees, transitions, and bends that match the underdrain material type. Close the upper ends of underdrains with suitable plugs.

Lay perforated underdrain so that the perforations are in the bottom half of the underdrain.

C. Backfilling. Inspect the underdrains before placing any granular material. Place the granular material for the full width of the trench around the underdrain, and extend it to the bottom of the pavement or base as shown on the plans. If underdrains are placed outside of the pavement or base area, extend the granular material to within 4 inches (100 mm) of the finished grade. Fill the remaining depth of the trench with 203 embankment material.

D. Protection. Place the pavement over the underdrain trench within 90 days after placing the trench backfill. If the trench remains open for longer than 90 days, remove and replace backfill contaminated by soil.

605.04 Construction Underdrains. Construct construction underdrains as follows:

A. Excavation. Construct the trench width to at least 10 inches (250 mm) with a minimum of 2 inches (50 mm) on each side of the underdrain. Excavate the bottom of the trench to allow proper placing of the underdrain. Remove obstructions encountered while excavating for the underdrains.

B. Trench Depth and Backfill. Construct the trench depth to that shown on the plans or 30 inches (750 mm). Backfill the trench with granular material for the full width of the trench and to the full height of the trench.

C. Outlet. Outlet the construction underdrains as possible into the ditch or drainage structures. There is no change in pipe types for the outlet.

D. Removal. Construction underdrains are not to be removed at any time. If the construction practice used requires the construction underdrains to be removed then install replacements as soon as possible.

605.05 Prefabricated Edge Underdrains. Install the prefabricated edge underdrains against the outside wall of a 4 inch (100 mm) trench, and backfill the trench adjacent to the pavement with granular material. Place the granular material in one or more lifts with a vibratory compactor run over the final lift to compact the granular material before placing the asphalt plug. Place the first layer of the granular material simultaneously with the trenching operation to hold the edge underdrains flush against the trench wall.

Splice the prefabricated edge underdrains as required before placing in the trench, using material furnished by the manufacturer and according to the manufacturer's directions. Require the manufacturer to furnish all material required for the splices,

and furnish any equipment required for splicing. Construct splices to prevent separation of adjoining sections of the prefabricated edge underdrain panels.

605.06 Underdrain Outlets. Construct pipe outlets concurrently with underdrains. Provide all outlets on the slope with a precast reinforced concrete outlet according to Item 611 and a tied concrete block mat Type 1 grouted according to 601.12.

Construct the underdrains outlets according to Item 611 using outlet fittings. Require the manufacturer to supply outlet fittings that transition between the underdrains and the outlet pipe. Provide smooth-lined or corrugated outlet fittings. Have the underdrains and outlets on fractured slab projects, such as crack and seat, rubblized, or break and seat projects, in place and functional before fracturing the existing pavement.

Mark all underdrain outlets with a wooden lath prior to final seeding. Clean all debris from the outlets after final seeding.

605.07 Aggregate Drains. Construct the aggregate drains after the completion of granular pavement courses.

A. Spacing. Space aggregate drains at 50 foot (15 m) intervals on each side of normal crowned sections, staggered so that each drain is 25 feet (7.5 m) from the adjacent drain on the opposite side, and at 25 foot (7.5 m) intervals on the low side only of superelevated sections. For rigid pavements, adjust the spacing to match the end of a transverse joint. Construct an aggregate drain on both sides of the low point of each sag vertical curve or the low side only in superelevated sections.

B. Excavation. Excavate trenches for aggregate drains to a minimum width of 12 inches (0.3 m) and to the depth shown on the plans. Slope the bottom of the trench to drain and keep it free from loose particles of soil. Excavate the trench to furnish a clean exposure of the granular pavement courses.

C. Placing and Backfilling. Use granular material for the drains. Place the aggregate to a minimum depth of 8 inches (200 mm) above the bottom of the trench. The remaining depth of the trench backfill with suitable embankment material according to Item 203.

605.08 Method of Measurement. The Department will measure Unclassified Pipe Underdrains, Shallow Pipe Underdrains, Deep Pipe Underdrains, Base Pipe Underdrains Construction Underdrains, Rock Cut Underdrains, and Prefabricated Edge Underdrains by the number of feet (meters) completed and accepted in place, measured from end to end of each run.

The Department will measure Aggregate Drains by the number of feet (meters) completed and accepted in place, measured along the bottom of the trench.

605.09 Basis of Payment. The Department will pay for pipe outlets under 611.

The Department will pay for precast reinforced concrete outlets under 611 Precast Reinforced Concrete Outlet.

The Department will pay for tied concrete block mats Type 1 grouted under 601 Tied Concrete Block Mat.

Rock Cut Underdrains are placed in rock and all required trenching in the rock is included under Rock Cut Underdrain.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
605	Foot (Meter)	____ " (____ mm) Unclassified Pipe Underdrains
605	Foot (Meter)	6" (150 mm) Construction Underdrains 707.31
605	Foot (Meter)	____ " (____ mm) Shallow Pipe Underdrains
605	Foot (Meter)	____ " (____ mm) Deep Pipe Underdrains
605	Foot (Meter)	____ " (____ mm) Base Pipe Underdrains
605	Foot (Meter)	Aggregate Drains
605	Foot (Meter)	____ " (____ mm) Rock Cut Underdrains
605	Foot (Meter)	____ " (____ mm) Prefabricated Edge Underdrains

ITEM 606 GUARDRAIL

606.01 Description. This work consists of constructing or reconstructing guardrail, guardrail posts, bridge terminal assemblies, end terminals, and impact attenuators, including the furnishing, assembling, and erecting of all component parts and materials.

Guardrail shall be deep beam rail Type MGS, 5, 5A, or 8. Appurtenances shall include bridge terminal assemblies, end terminals, and impact attenuators. Construction of the various types of guardrail include the furnishing, assembling, and erecting of all component parts and materials, complete in place, at the location shown on the plans or as directed, and according to the manufacturer's recommendations where applicable.

606.02 Materials. Furnish materials conforming to:

Concrete, Class QC Misc, QC 1, QC 2..... 499 and 511
Reinforcing steel..... 509.02
Deep beam rail and hardware 710.06
Pressure treated guardrail posts
and blockouts 710.14
Steel guardrail posts..... 710.15
Guardrail posts..... 710.16
Galvanizing 711.02

For guardrail, use deep beam rail Type MGS. 5, 5A, or 8.

When using round wooden posts, construct type MGS using posts 69 in (1.75 m) in length.

606.03 Setting Posts. Set or drive posts plumb in a manner that prevents battering or distorting of posts. Trim posts that are set or driven more than 1 inch (25 mm) above grade. Treat trimmed posts with a preservative material specified in 712.06. Backfill post holes with acceptable material, placed in layers, and thoroughly compacted.

606.04 Erecting Rail Elements. Erect standard design (single-faced) guardrail of the type shown on the plans. Erect barrier design (double-faced) guardrail as shown on the plans.

Erect rail elements in a manner resulting in a smooth, continuous installation. Use shop-curved rail on curves with radii from 5 to 70 feet (1.5 to 22.4 m).

Except where otherwise required, such as expansion joint bolts, draw bolts tight. Tighten bolts through expansion joints as tight as possible without preventing the rail elements from sliding past one another longitudinally. Provide bolts long enough to extend at least 1/4 inch (6 mm) beyond the nuts.

Do not use splice bolts that extend more than 1/2 inch (13 mm) beyond the nuts. For double-faced guardrail, provide bolts that extend from 1/4 to 1 inch (6 to 25 mm) beyond the nuts.

Fabricate all metal in the shop. Do not perform burning or welding in the field. The Engineer may approve making holes in the field, but only for special details in exceptional cases. The Engineer may approve field punching, cutting, and drilling if the Contractor demonstrates that its methods do not damage the surrounding metal.

Repair galvanized surfaces that have been abraded such that the base metal is exposed, including threaded portions of all fittings and fasteners, and cut ends of bolts as specified by ASTM A 780 except the Department will not allow aerosol spray applications of paints containing zinc dust.

Erect guardrail so that the bolts at expansion joints are located at the centers of the slotted holes. Splice the rail elements by lapping in the direction of traffic. Ensure that the plates at each splice make contact throughout the area of the splice.

606.05 Guardrail Rebuilt. As shown on the plans, rebuild existing guardrails. Unless otherwise shown on the plans, rebuild units of the same type and spacing of members as the existing guardrail.

For re-erecting, obtain the rail element from specified salvage sources. Furnish the following new materials: posts, blockouts, bolts, washers, and incidental hardware as necessary to complete the guardrail, except: (1) existing steel posts and blockouts that are not damaged and have a good galvanized coating may be reused, and (2) reuse guardrail splice bolts that are undamaged and were not removed during salvage may be reused.

606.06 Impact Attenuators. Before installing the attenuator, make all corresponding shop drawings from the manufacturer available for the Engineer's

inspection. Include installation drawings and instructions with the shop drawings that completely describe the attenuator system.

Grade the top of each foundation at the same elevation as the adjacent travel lane and/or paved shoulder.

Adjust the location of the anchors to avoid pavement joints.

The Contractor shall use approved proprietary impact attenuator products as required which can be found on the Office of Roadway Engineering's website.

Cover the face of the impact head with solid fluorescent yellow Type G reflective sheeting conforming to 730.19.

606.07 Method of Measurement. The Department will measure Guardrail, new or rebuilt, of the type specified by the number of feet (meters) from center-to-center of end posts, excluding anchor assemblies. If, however, end connections are made to masonry or steel structures, the Department will measure to the center of the normal post bolt slot. If rail element is used across a bridge, the Department will measure to the first post off the bridge.

The Department will measure Anchor Assembly of the type specified by the number each assembly furnished and erected complete.

The Department will measure Bridge Terminal Assembly of the type specified by the number of each assembly furnished and erected complete.

The Department will measure Impact Attenuator of the type specified by the number of each furnished and erected complete.

The Department will measure Guardrail Post of the kind specified by the number of each furnished and erected.

606.08 Basis of Payment. The additional costs associated with furnishing and installing extra-length posts instead of standard-length guardrail posts are incidental to Guardrail Post, 8 foot (2.44 m) or Guardrail Post, 9 foot (2.75 m).

For the extra costs associated with furnishing and installing extra-length posts in lieu of standard-length guardrail posts, payment for 9 foot (2.75 m) guardrail posts is considered full compensation.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
606	Foot (Meter)	Guardrail, Type ___
606	Foot (Meter)	Guardrail, Barrier Design, Type ___
606	Foot (Meter)	Guardrail, Rebuilt, Type ___
606	Each	Anchor Assembly, Type ___
606	Each	Anchor Assembly, Barrier Design, Type ___
606	Each	Bridge Terminal Assembly, Type ___
606	Each	Impact Attenuator, Type ___
606	Each	Guardrail Post
606	Each	Guardrail Post, 8 foot (2.44 m)
606	Each	Guardrail Post, 9 foot (2.75 m)

ITEM 607 FENCE

607.01 Description. This work consists of furnishing and erecting fence and gates of the types designated. Construct fence in a manner that provides a rigid, taut fence closely conforming to the surface of the ground.

Fence is designated by the following types:

A. Type 47 [47 inch (1195 mm)] woven wire fence fabric, steel line posts, and one strand of barbed wire.

B. Type 47RA [47 inch (1195 mm)] woven wire fence fabric, wood line posts, and no barbed wire.

C. Type CLT [60 inch (1525 mm)] chain-link fence fabric with tension wire.

607.02 Materials. Furnish materials conforming to:

Concrete, QC Misc or QC 1 or QC 2	499 and 511
Reinforcing steel	509.02
Barbed wire	710.01
Woven steel wire fence	710.02
Chain-link fence	710.03
Fence posts, braces, and dimension lumber	710.11
Steel line posts and ties, Type 47 fence	710.11
Expansion shield anchors, self drilling	712.01
Seeding and Mulching	659

607.03 Clearing, Grading and Seeding. Perform clearing and grading as necessary to construct the fence to the required alignment, and provide a reasonably smooth ground profile at the fence line. Perform fenceline seeding and mulching according to Item 659 Seeding and Mulching on all areas disturbed by the clearing and grading for the fence within 8 months of the activity. The Department will deduct the area paid for under Item 607 Fenceline Seeding and Mulching from Item 659 Seeding and Mulching quantities as described in the plan, if applicable.

607.04 Post Assemblies. Securely brace end, corner, gate, and pull or intermediate anchor posts in position during the curing period of the concrete encasement. The Engineer will not require forms for post encasement.

For Type 47 and Type CLT fence, ensure that the maximum spacing between intermediate anchor post assemblies, or between end post assemblies and intermediate anchor post assemblies, are 660 feet (200 m).

607.05 Horizontal Deflection. At points of horizontal deflection, construct the fence as follows:

A. Type 47 Fence. If the fence changes alignment by more than 1 degree but not more than 4 degrees, install either steel line posts encased in concrete or wood posts without encasement at all horizontal deflection points. If the change in alignment is more than 4 degrees and less than 30 degrees, build an intermediate anchor post assembly at the deflection point. If the change in alignment is 30 degrees or more, build a corner post assembly at the deflection point.

B. Type CLT Fence. If the fence changes alignment by more than 1 degree but not more than 4 degrees, install line posts encased in concrete at all horizontal deflection points. If the change in alignment exceeds 5 degrees, provide a post brace and truss rod in each fence panel adjacent to the post located at the angle point. If the change in alignment exceeds 5 degrees, construct the footings for all post located at deflection points as specified for end posts.

607.06 Line Posts. Set line posts according to the following:

A. Type 47 Fence. Space line posts at intervals not to exceed 12 feet (3.6 m). Anchor line posts at the bottom of dips or depressions in the ground surface in concrete. If channels or streams cross the fence line, construct crossings as shown on the plans.

On tangents, place line posts so that the fabric, when installed on the side toward the highway, is 2 feet (0.6 m) from the Right-of-Way line. If adjacent to Right-of-Way lines with less than 5740 feet (1750 m) radius (in excess of 1 degree curvature), construct line posts on chords so that the fabric, when installed on the side toward the highway, is not less than 2 feet (0.6 m) or more than 8 feet (2.4 m) from the Right-of-Way line.

Locate posts at points of horizontal deflection so that the fence fabric will bear against the post.

B. Type CLT Fence. Protect the tops of driven line posts by drive caps or other method to prevent distortion of the exposed end. Space line posts at not more than 10-foot (3 m) centers, and place them so that, when the wire is fastened on the side toward the highway, it is 1 foot (0.3 m) from the Right-of-Way line.

607.07 Fabric. If setting posts in concrete, do not erect the fabric until after 5 days from the time of setting the posts when using regular concrete, or until after 3 days when using concrete with high early strength cement,

Stretch and securely fasten Type 47 fabric to line posts using galvanized ties. At a minimum, use one tie each for the top and bottom horizontal wires and one tie for each alternate horizontal wire below the top horizontal wire.

Fasten chain-link fabric to the line posts using clips or bands spaced approximately 14 inches (0.4 m) apart, and to the top rail or top tension wire using bands or tie wires at approximately 24 inch (0.6 m) intervals or less. Join successive rolls of fabric by weaving a single picket into the ends of the rolls to form a continuous mesh.

607.08 Barbed Wire. If barbed wire is specified, stretch and fasten it in the same manner as woven wire fabric.

607.09 Method of Measurement. The Department will measure Fence, Type ___ by the number of feet (meters), complete in place. The Department will measure along the top of the fence from outside to outside of end posts, exclusive of gates and other openings.

The Department will count Gate, Type ___ by the number of complete units of the size and type specified.

The Department will measure Fenceline Seeding and Mulching by the number of feet (meters) of fence. The Department will measure along the top of the fence from outside to outside of end posts, exclusive of gates and other openings.

607.10 Basis of Payment. The Department will pay for accepted quantities at the contract prices as follows:

Seeding and Mulching shall be paid under Item 607 Seeding and Mulching

Item	Unit	Description
607	Foot (Meter)	Fence, Type___
607	Each	Gate, Type___
607	Foot (Meter)	Fenceline Seeding and Mulching

ITEM 608 WALKS, CURB RAMPS, AND STEPS

608.01 Description. This work consists of constructing walks, curb ramps, and steps as per plans, specifications and standard drawings.

608.02 Materials. Furnish materials conforming to:

Aggregate Base.....304.01 and 304.02
Asphalt concrete Type 1.....441
Concrete, Class QC Misc. or QC 1* 499
Reinforcing steel..... 509.02
Liquid Membrane-Forming Compounds
for Curing Concrete..... 705.07
Concrete Sealers, non-epoxy 705.23B
Crushed aggregate meeting
grading requirements of..... 703.10

Detectable Warning Devices 712.14
Expansion joint material..... 705.03

* Replacing Coarse aggregate in the concrete mixes with Recycled Concrete Aggregate conforming to Supplement 1117 is an option.

608.03 Concrete Walks. Construct concrete walks as follows:

A. Excavation. Excavate to the required depth and to a width that allows installation and bracing of forms. Shape and uniformly compact the subgrade to a surface conforming to the plans.

B. Forms. Use either fixed forms or slip-form methods. For fixed-form construction, use wooden or metal forms that extend the full depth of the concrete and that do not spring under the concrete pressure. For slip-form construction, perform the work according to 609.04.C.

C. Placing and Finishing. Immediately before placing concrete, thoroughly moisten the subgrade. Deposit concrete in a single layer, strike it off with a template, and smooth it with a float to obtain a sandy texture. Do not plaster the concrete. Use a 1/4 inch (6 mm) radius edging tool to edge all outside edges and joints. Divide the surface of the walks into equally spaced rectangular blocks at approximately 5 foot (1.5 m) intervals. Saw or form transverse joints to a depth of not less than one-fourth the thickness of the slab and to a width of approximately 1/8 inch (3 mm). Install 1/2 inch (13 mm) thick expansion joint filler between the walk and any fixed structure that extends the full depth of the walk. Install 1 inch (25 mm) thick expansion joint filler between the walk and the back of curb that is on a 250 foot (75 m) or smaller radius, such as at street intersections. Follow Item 511.12 for concrete placement during cold weather conditions.

D. Slope. Construct the surface of the walk with a maximum transverse slope rate of 0.02 and with the low side adjacent to the roadway.

E. Curing and Treating. Cure concrete according to Item 451.11.

608.04 Asphalt Concrete Walks. Construct asphalt concrete walks as follows:

A. Excavation and Forms. Excavate and construct forms according to 608.03.A and 608.03.B.

B. Base. Place and thoroughly compact aggregate base in layers not exceeding 4 inches (100 mm) in depth.

C. Asphalt Placement and Compaction. Place asphalt concrete in one or more courses to provide the required depth. Compact using a hand roller or power roller of a type and weight acceptable to the Engineer.

608.05 Crushed Aggregate Walks. Construct crushed aggregate walks as follows:

A. Excavation. Excavate according to 608.03.A.

B. Forms. Construct forms of wood or metal of acceptable rigidity and to the depth of the necessary loose material. Back forms with compacted soil to the height of the completed walk.

C. Aggregate Placement and Compaction. Place aggregate in one or more courses to provide the required depth. Compact using equipment of a type and weight acceptable to the Engineer.

608.06 Concrete Steps. Construct concrete steps as follows:

A. Excavation and Forms. Excavate and construct forms according to 608.03.A and 608.03.B.

B. Placing and Finishing. Place and finish concrete according to Item 511.15, and 511.18, except finish the treads of steps to produce a sandy texture according to 511.07.

C. Slope. Slope step treads at a rate of 0.01 and toward the next lower step.

D. Curing and Treating. Cure and treat steps according to 608.03.E.

E. Railing. If specified, install hand railing according to Item 517.

608.07 Curb Ramps. Excavate, form, place, finish, and cure according to 608.03.A, 608.03.B, 608.03.C, and 608.03.E. Finish ramps to a rougher final surface texture than the adjacent walk and with striations transverse to the ramp slope using a coarse broom or other method approved by the Engineer.

Provide detectable warning devices conforming to 712.14 in curb ramps. Install the detectable warning devices according to manufacturer's written recommendations and standard drawings. Provide a warranty to conform with the requirements of 712.14. Provide the manufacturer's written installation instructions and the 5 year warranty to the Engineer at or before the pre-construction meeting.

608.08 Method of Measurement. The Department will measure Concrete Walk, Asphalt Concrete Walk, and Aggregate Walk by the number of square feet (square meters) of finished surface, complete in place.

The Department will measure curb ramps by the number of square feet (square meters) completed. The Department will measure detectable warnings in existing curb ramps and at grade crossings by the number of square feet (square meters) completed.

The Department will measure Concrete Steps by the number of feet (meters), along the front edge of each tread. Where steps are constructed with integral walls, the Department will include the thickness of the integral walls with the tread width measurement.

608.09 Basis of Payment. Payment for walks, curb ramps, detectable warnings, and steps is full compensation for excavation, backfill, concrete cutting/sawing, base course material, reinforcing steel, hand railing, expansion joint materials, and any incidentals required to complete the installation as specified. The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
608	Square Foot (Square Meter)	Concrete Walk
608	Square Foot (Square Meter)	Asphalt Concrete Walk

608	Square Foot (Square Meter)	Aggregate Walk
608	Square Foot (Square Meter)	Curb Ramp
608	Square Foot (Square Meter)	Detectable Warning
608	Foot (Meter)	Concrete Steps

ITEM 609 CURBING, CONCRETE MEDIANS, AND TRAFFIC ISLANDS

609.01 Description. This work consists of furnishing and constructing curb, combination curb and gutter, medians, and traffic islands. This work also consists of excavating, backfilling, furnishing and installing joint materials, and disposing of surplus excavation and discarded materials according to Item 203.

609.02 Materials. Furnish materials conforming to:

Concrete, Class QC Misc. or QC 1*.....499
Preformed filler..... 705.03
Liquid Membrane-Forming Compounds
for Curing Concrete..... 705.07
Concrete Sealers, non-epoxy……...705.23. B
Tie bar steel, epoxy coated
.....709.00, 709.01, 709.03, 709.05
Coated dowel bars..... 709.13
* Replacing Coarse aggregate in the concrete mixes with Recycled Concrete Aggregate conforming to Supplement 1117 is an option

Furnish the best quality of Berea or Amherst gray sandstone, or sandstone of equal quality.

Furnish asphalt concrete curb conforming to 441 Type 1 intermediate course. Conform the asphalt concrete to the composition requirements with the fine aggregate content set at the maximum allowed under this composition. Provided the Contractor meets the composition requirements, the Contractor may add mineral filler conforming to 703.07. Add the mineral filler using a method approved by OMM.

609.03 Stone Curb

A. Cutting and Dressing. Ensure that 95 percent of all straight curb pieces are at least 5 feet (1.5 m) long, with no pieces less than 42 inches (1.1 m). The Contractor may use a piece as short as 30 inches (0.8 m) for closure. For curves with a radius of 50 feet (15 m) or greater, the Contractor may use radially jointed straight curb pieces between 36 and 42 inches (0.9 and 1.1 m) long. For curves and corners with a radius of less than 50 feet (15 m), use pieces a minimum of 36 inches (0.9 m) long, and dress, joint, and set pieces to the radii specified. For all curves and corners, use curb sections that are approximately uniform in length.

Dress all curb to a straight edge on top and on the exposed face and ends to a depth of at least 6 inches (150 mm) below the gutter elevation. Dress the ends at right angles to the face for straight curb and radially for curb on curves. Do not allow slack or hollow joints. Do not leave any projections after dressing the ends of any curb section that exceed 1/8 inch (3 mm) from the plane of the end of that section. Cut the edge next to the gutter to a 3 inch (75 mm) radius and dress the top to a 1/4 inch (6 mm) bevel rising from the exposed face. Use a pitching tool on the edge at the back to hand dress curb to the specified width.

B. Setting. Set the curb on a thoroughly compacted subgrade and with a 1 in 20 batter from the vertical backward from the gutter. Place a minimum 3 inch (75 mm) thick firm bed of aggregate material as a foundation for the curb. Use a heavy rammer to settle the curb into place. Place and compact a minimum 4 inch (100 mm) wide aggregate backfill behind the curb to within 6 inches (150 mm) of the top. Bring the balance of the backfill to the level of the top of the curb for a distance of 2 feet (0.6 m) behind the curb with soil or other acceptable material. Thoroughly tamp the backing in layers not exceeding 6 inches (150 mm) in thickness, loose measurement, with an approved tamper or rammer. Perform as much of the backfilling and tamping as is consistent with alignment of the curb at the time the stone is first set. Set curb on curves in plastic concrete 6 inches (150 mm) thick as shown on the plans. Extend concrete the width of the curb plus 6 inches (150 mm) behind the curb, and bring concrete up behind the curb to within 4 inches (100 mm) of the top.

C. Joints. Set curbs such that below the dressed portions the space between ends of adjacent sections of curbing is not less than 1/8 inch (3 mm) at any point and not more than 4 inches (100 mm). Cushion the joints between the dressed portions of adjacent sections of curbing with 1/8-inch (3 mm) thick expansion joint material. Trim expansion joint material flush with the curbing on all edges.

If placing sandstone curb after placing pavement, fill remaining joints with dry sand to within 2 inches (50 mm) of the surface of the pavement, and fill to the pavement surface with asphalt concrete. Take care in filling this joint so that no asphalt concrete comes in contact with the exposed surface of the curb.

D. Reusing Existing as New Curb. If specifically allowed by the plans, and to the extent available, use acceptable stone curb sections removed under Item 202 instead of furnishing new stone curb. Use salvaged curb at locations designated by the Engineer. Place all salvaged sections of curb continuously without interspersing salvaged and new curb sections. Haul and store salvaged curb as necessary. Cut, dress, set, and install joints in salvaged curbs according to the requirements for new curbs.

609.04 Cast-in-Place Concrete Curb and Combination Curb and Gutter.

A. Forms and Joints. Use approved steel forms for curbs. Securely brace and hold forms to the line and grade shown on the plans. The Contractor may use approved flexible forms of steel or wood to construct curved curb with a radius of 200 feet (60 m) or less. Immediately before placing concrete, clean the inner surface of the forms, and coat this surface with a form release agent.

Where curb and combination curb and gutter is not constructed integral with, or tied to, the base or pavement, construct 1/4-inch (6 mm) wide contraction joints at 10 feet (3 m) intervals using steel separator plates, a grooving tool, or a saw according to Item 451. For combination curb and gutter, construct the joint to an average depth of 2 inches (50 mm) or more. For curb, construct the joint to an average depth of one-fifth or more of the curb height. Where expansion joints occur in the abutting pavement, separate the section being placed with 1 inch (25 mm) thick 705.03 preformed filler.

Where the curb is integral with, or tied to, the base or pavement, construct the same type of joints as used in the pavement. Space joints identically with the joints in the base or pavement.

Leave curb forms in place until their removal will not crack, shatter, or otherwise injure the concrete. Do not seal transverse joints in cast-in-place concrete curb and combination curb and gutter.

If curbs are to later serve as a support for a finishing machine in the placing of a surface course, align supporting edges so that the distance between the curbs is within 1/2 inch (13 mm) from that specified.

B. Placing. Place concrete in forms prepared as described above, and vibrate the concrete to eliminate all voids.

Place concrete for curb that is integral with the concrete base or pavement while the base or pavement concrete is plastic. Where the presence of the finishing equipment on the forms at the end of the day's run prevents completing the curb, install No. 5 (No. 16M) tie bars vertically in the pavement at 1 foot (0.3 m) intervals and in a line 3 inches (75 mm) inside of and parallel to the pavement edge. Install these tie bars to within 1 1/2 inches (38 mm) of the subgrade or subbase and 2 inches (50 mm) above the concrete base or pavement surface. Water cure this horizontal construction joint between the concrete base or pavement and the curb, or membrane cure the concrete base or pavement and remove the membrane before placing the curb. Immediately before placing the concrete curb, brush mortar (consisting of one part cement to two parts sand with enough water to form a workable mortar) into the surface area of the hardened concrete pavement or base where the curb is to be placed. Do not allow the mortar to dry before placing the curb on top of it.

C. Slip-Form Placement. The Contractor may use a self-propelled machine to place concrete curb or curb and gutter. Force the concrete through a mold of the proper cross-section to obtain the proper density and cross-section. If using a track, set and secure the track on which the machine operates to the exact line and grade given by the Engineer. Use concrete of a consistency that provides the desired shape and remains as placed without slumping of the vertical faces.

D. Finishing. Without adding extra mortar, float the top of the curb to thoroughly compact the concrete and produce a smooth and even surface. Round the edges of the curb using a tool specially designed for this purpose. Immediately after removing the forms, rub the exposed face of the curb with a float to eliminate unnecessary tool marks. Provide a finished surface free of irregularities and waves, and uniform in texture.

E. Protection. Cure concrete according to 451.11

609.05 Asphalt Concrete Curb. Use one of the following methods, or other method approved by the Engineer, to furnish and place an asphalt concrete curb of the required cross-section.

A. Method A. After completing the surface course, paint or spray only the area to be occupied by the asphalt concrete curb with asphalt material conforming to 407.02. Apply the asphalt material at the rate of 0.15 gallon per square yard (0.7 L/m2). Place the curb with a hand-operated or self-propelled machine consisting of a hopper and power-driven screw, which forces the material through an extrusion tube. Force the material through a die attached to the end of the extrusion tube to obtain the proper density and cross-section.

B. Method B. As an independent operation preceding the final rolling of the asphalt concrete surface course on which the curb is placed, place loose asphalt concrete of sufficient height. Shape the loose asphalt concrete by hand methods using suitable templates or by other means to produce the specified cross-section. Compact the loose asphalt concrete using a hand-operated mechanical vibrating tamper equipped with a compacting shoe of such shape that will produce the specified final cross-section dimensions of the curb.

609.06 Concrete Median and Traffic Island

A. Forms and Joints. Securely brace and hold approved steel forms to the line and grade shown on the plans. The Contractor may use approved flexible forms of steel or wood to construct curves with a radius of 200 feet (60 m) or less. Immediately before placing concrete, clean the inner surface of the forms, and coat this surface with a form release agent.

Where medians and traffic islands are not anchored to the pavement, construct contraction joints at 10-foot (3 m) intervals using steel separator plates, a grooving tool, or saw according to Item 451. Construct joints to a minimum depth of 2 inches (50 mm).

Where the medians or traffic islands are anchored to the pavement, construct the same type of joints in the median or traffic island as used in the pavement. Construct joints to a minimum depth of 2 inches (50 mm) using steel separator plates, a grooving tool, or saw according to Item 451. Space the joints identically with the joints in the pavement.

Leave forms in place until their removal will not crack, shatter, or otherwise injure the concrete.

B. Placing. Immediately before placing a concrete median or traffic island on subgrade, bring the subgrade to a thoroughly moistened condition by sprinkling with

water at such times and in such a manner directed by the Engineer. Follow 511.12 for concrete placement during cold weather conditions.

Place the concrete in forms prepared as described above, and vibrate the concrete to eliminate all voids.

C. Slip-Form Placement. The Contractor may use a self-propelled machine to place medians and traffic islands. Force the concrete through a mold of the proper cross-section to obtain the proper density and cross-section. If using a track, set and secure the track on which the machine operates to the exact line and grade given by the Engineer. Use concrete of a consistency that provides the desired shape and remains as placed without slumping of the faces.

D. Finishing. Without adding extra mortar, finish the top of the median or traffic island to a broom texture. Round the edges using a tool specially designed for this purpose. Immediately after removing the forms, rub the exposed faces with a float to eliminate unnecessary tool marks. Provide a finished surface free of irregularities and waves, and a uniform texture.

E. Curing and Treating. Cure concrete according to Item 451.11.

609.07 Method of Measurement. The Department will measure Sandstone Curb, Curb, Combination Curb and Gutter, and Asphalt Concrete Curb by the number of feet (meters) complete in place, measured along the front face of the curb section.

The Department will measure Concrete Traffic Island and Concrete Median by the number of square yards (square meters) or the number of cubic yards (cubic meters) complete in place.

609.08 Basis of Payment. The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
609	Foot (Meter)	Sandstone Curb
609	Foot (Meter)	Curb, Type ___
609	Foot (Meter)	Combination Curb and Gutter, Type ___
609	Foot (Meter)	Asphalt Concrete Curb, Type ___
609	Square Yard or Cubic Yard (Square Meter or Cubic Meter)	Concrete Traffic Island
609	Square Yard or Cubic Yard (Square Meter or Cubic Meter)	Concrete Median

ITEM 611 PIPE CULVERTS, SEWERS, DRAINS, AND DRAINAGE STRUCTURES

611.01 Description. This work consists of constructing conduits, and constructing and reconstructing drainage structures. This work also includes preparing installation plans, performing inspections, and providing reports and other required documentation.

611.02 Materials. Furnish conduit material of the specified conduit type and conduit size or one size larger with the approval of the Engineer. Conduit shown in the plans is designed for hydraulic capacity and the Material Durability Design. Provide conduit materials with Bedding and Structural Backfill materials that meet the structural design requirements of Supplement 1086 for each conduit run. Provide drainage structure materials with Bedding and Structural Backfill materials that will perform structurally for each location. Provide material descriptions and installation procedure details in the Installation Plans. Different conduit and drainage structure materials and the associated Bedding and Backfill may require varying installation procedures. If the conduit material is not specified in the plans, all material for that type of conduit will meet the Material Durability Design.

The Contractor may furnish concrete or plastic pipe of the same type with greater strength than specified. The Contractor may furnish metal pipe with a greater thickness than specified, so long as the pipe has the same corrugation profile and is the same type.

A. Type A Conduit – Culverts

Non-reinforced concrete pipe, Class 3..... 706.01
Reinforced concrete circular pipe 706.02
Reinforced concrete pipe, epoxy coated..... 706.03
Reinforced concrete elliptical pipe..... 706.04
Precast reinforced concrete box sections 706.05
Precast reinforced concrete 3-sided flat
topped culverts 706.051

Precast reinforced concrete arch sections 706.052
Precast reinforced concrete round sections 706.053
Corrugated steel conduits ..... 707.01 or 707.02
Structural plate corrugated steel structures 707.03
Precoated, galvanized steel culverts 707.04
Bituminous coated corrugated steel pipe and pipe arches with paved invert ..... 707.05 Type B or 707.07 Type B
Corrugated steel box culverts..... 707.15
Polymer Precoated, Galvanized Steel Conduits with precoated galvanized smooth interior liner. 707.18
Aluminum coated Steel Conduits with precoated galvanized smooth steel interior liner 707.19
Galvanized Coated Steel Conduits with precoated galvanized smooth steel interior liner ..... …707.20
Corrugated aluminum alloy pipe..... 707.21 or 707.22
Aluminum alloy structural plate conduits..... 707.23
Corrugated aluminum box culverts 707.25
Corrugated polyethylene smooth lined pipe..... 707.33
Polyethylene Plastic Pipe Based on Outside Diameter (OD) 707.34
Polyethylene Profile Wall Pipe 707.35
Corrugated Polypropylene Smooth Lined Pipe..... 707.65
Glass-fiber-reinforced polymer mortar pipe 707.75
Steel Reinforced Thermoplastic Ribbed pipe..... 707.85

B. Type B Conduit – Storm or sanitary sewers under pavement

Non-reinforced concrete pipe, Class 3..... 706.01
Reinforced concrete circular pipe 706.02
Reinforced concrete elliptical pipe..... 706.04
Precast reinforced concrete box sections 706.05
Vitrified clay pipe (extra strength only)..... 706.08
Polymer-precoated corrugated steel spiral rib pipe 707.11
Bituminous lined corrugated steel pipe .. 707.13 or 707.14
Polymer Precoated, Galvanized Steel Conduits with precoated galvanized smooth interior liner. 707.18
Aluminum coated Steel Conduits with precoated galvanized smooth steel interior liner 707.19
Galvanized Coated Steel Conduits with precoated galvanized smooth steel interior liner ..... …707.20
Corrugated aluminum spiral rib pipe..... 707.24
Corrugated polyethylene smooth lined pipe..... 707.33
Polyethylene Plastic Pipe Based on Outside Diameter (OD) 707.34
Polyethylene Profile Wall Pipe 707.35

Polyvinyl chloride corrugated smooth interior pipe 707.42
Polyvinyl chloride profile wall pipe 707.43
Polyvinyl chloride solid wall pipe..... 707.45
Polyvinyl chloride drain waste and vent pipe 707.46
Polyvinyl chloride ABS composite pipe..... 707.47
Polyvinyl chloride large-diameter solid wall pipe.. 707.48
ABS drain waste and vent pipe 707.51
Corrugated Polypropylene Smooth Lined Pipe..... 707.65
Glass-fiber-reinforced polymer mortar pipe 707.75
Steel Reinforced Thermoplastic Ribbed pipe..... 707.85
Ductile iron pipe (sanitary)..... 748.01
Polyvinyl chloride pipe (sanitary) 748.02

C. Type C Conduit – Storm or sanitary sewers not under pavement

Non-reinforced concrete circular pipe 706.01
Reinforced concrete pipe..... 706.02
Reinforced concrete elliptical pipe..... 706.04
Precast reinforced concrete box sections 706.05
Vitrified clay pipe (extra strength only)..... 706.08
Polymer-precoated corrugated steel spiral rib pipe 707.11
Bituminous lined corrugated steel pipe .. 707.13 or 707.14
Polymer Precoated, Galvanized Steel Conduits
with precoated galvanized smooth
interior liner. 707.18
Aluminum coated Steel Conduits with
precoated galvanized smooth steel
interior liner 707.19
Galvanized Coated Steel Conduits with
precoated galvanized smooth steel
interior liner ..... …707.20
Corrugated aluminum spiral rib pipe..... 707.24
Corrugated polyethylene smooth lined pipe..... 707.33
Polyethylene Plastic Pipe Based on Outside Diameter
(OD) 707.34
Polyethylene Profile Wall Pipe 707.35
Polyvinyl chloride corrugated smooth interior pipe 707.42
Polyvinyl chloride profile wall pipe 707.43
Polyvinyl chloride solid wall pipe..... 707.45
Polyvinyl chloride drain waste and vent pipe 707.46
Polyvinyl chloride ABS composite pipe..... 707.47
Polyvinyl chloride large-diameter solid wall pipe.. 707.48
ABS drain waste and vent pipe 707.51
Polypropylene Corrugated Double Wall Pipe 707.65
Glass-fiber-reinforced polymer mortar pipe 707.75
Steel Reinforced Thermoplastic Ribbed pipe..... 707.85
Ductile iron pipe (sanitary)..... 748.01
Polyvinyl chloride pipe (sanitary) 748.02

D. Type D Conduit – Drive pipes and bikeways

Non-reinforced concrete pipe, Class 3..... 706.01

Reinforced concrete circular pipe 706.02
Reinforced concrete elliptical pipe..... 706.04
Corrugated steel conduits ..... 707.01 or 707.02
Structural plate corrugated steel structures 707.03
Corrugated aluminum alloy pipe..... 707.21 or 707.22
Aluminum alloy structural plate conduits..... 707.23
Corrugated polyethylene smooth lined pipe..... 707.33
Polyvinyl chloride corrugated smooth interior pipe 707.42
Polyvinyl chloride profile wall pipe 707.43
Polyvinyl chloride solid wall pipe..... 707.45
Polyvinyl chloride large-diameter solid wall pipe.. 707.48
Polypropylene corrugated single wall pipe 707.62

E. Type E Conduit – Miscellaneous small drain connections and headers

Non-reinforced concrete pipe 706.01
Reinforced concrete circular pipe 706.02
Reinforced concrete elliptical pipe..... 706.04
Concrete drain tile, extra quality..... 706.07
Vitrified clay pipe (extra strength only)..... 706.08
Clay drain title, extra quality 706.09
Corrugated steel conduit..... 707.01 or 707.02
Corrugated aluminum alloy pipe..... 707.21 or 707.22
Corrugated polyethylene drainage pipe 707.32
Corrugated polyethylene smooth lined pipe..... 707.33
Smooth-wall polyvinyl chloride underdrain pipe
(non-perforated) 707.41
Polyvinyl chloride corrugated smooth interior pipe 707.42
Polyvinyl chloride profile wall pipe 707.43
Polyvinyl chloride solid wall pipe..... 707.45
Polyvinyl chloride drain waste and vent pipe 707.46
Polyvinyl chloride ABS composite pipe..... 707.47
Polyvinyl chloride large-diameter solid wall pipe.. 707.48
ABS drain waste and vent pipe 707.51

F. Type F Conduit – Conduit on steep slopes; underdrain outlets

Corrugated steel conduits
(steep slope conduit)..... 707.05 Type C or 707.07
Corrugated aluminum alloy pipe
(steep slope conduit)..... 707.21 or 707.22
Corrugated polyethylene
smooth lined pipe 707.33
Smooth-wall polyvinyl chloride underdrain pipe
(non-perforated underdrain outlets) 707.41
Polyvinyl chloride corrugated
smooth interior pipe (underdrain outlets)..... 707.42
Polyvinyl chloride solid wall pipe
(underdrain outlets) 707.45

G. For constructing or reconstructing drainage structures, furnish materials conforming to:

Concrete, Class QC1. ..... 511, 499
Brick and masonry units 704
Precast reinforced concrete manhole, catch basin, and inlet sections 706.13
Precast reinforced concrete outlet 706.15
Preformed expansion joint filler 705.03
Epoxy coated reinforcing steel 709.00
Cast frames, grates, and covers ..... 711.12, 711.13, or 711.14
Welded frames and grates ..... 711.01 and 513.17
Steps ..... 711.13, 711.30, or 711.31
Resilient and flexible gasket joints 706.11
Curing materials 705.05, 705.07
Curing membrane for inlets ..... 705.07, Type 1 or 1-D
Mortar 602
Nonshrink mortar… ..... ……705.22

H. For bedding and backfill, furnish materials conforming to:
Bedding 613, 703.11
Structural Backfill 613, 703.11
Final Backfill:
Granular Structural Backfill 703.11
Natural Soils ..... 703.16.A[1]
Granular Embankment Materials ..... 703.16.B[1]
Granular Embankment Material Types A, B, C and D ..... 703.16.C[1]
Coarse aggregate ..... Table 703.01-1
Fine aggregate ..... 03.02.A, 703.03, or 703.05.A
304 ..... 703.17.A
410, 411, and 617 ..... 703.18.A[1]
Low Strength Mortar Backfill (LSM) 613

[1] Use any type of material defined as suitable materials for embankment construction except for steel slag, PCS and RAP.

I. For concrete collars and encasement, furnish materials conforming to:
Concrete, Class QC 1 ..... 511, 499
Reinforcing steel 509.02

J. For field paving of conduit inverts, furnish materials conforming to:
Concrete, Class QC 5, QC Misc. 511, 499
Coarse aggregate, size No. 7, 8, or 78 ..... 703.02
Galvanized welded wire fabric 709.08

For material in items not specified above, furnish materials conforming to:

Mortar 602
Nonshrink mortar 705.22
Concrete Sealers 705.23
Bituminous pipe joint filler 706.10
Resilient and flexible gasket joints for:
Concrete pipe 706.11
Vitrified clay pipe 706.12

Preformed flexible joint sealant 706.14
Type 2 membrane waterproofing 711.25
Type 3 membrane waterproofing 711.29
Geotextile Fabric ..... 712.09, Type A
Joint wrap ..... ASTM C 877, Type III
Buried liner waterproofing membrane 711.22

For Class QC1 concrete, provide batch plant tickets according to 499.07.

If a precast reinforced concrete box culvert (706.05) is specified, the Engineer may allow the Contractor to substitute either a precast reinforced concrete 3-sided flat topped culvert, a precast reinforced concrete arch culvert, or a precast reinforced concrete round section (706.051, 706.052, or 706.053). If a 706.051, 706.052, or 706.053 is specified, the Engineer may allow the Contractor to substitute one for the other. Refer to 611.04 for submittal requirements.

If bituminous coated corrugated steel pipe or pipe arch with paved invert (707.05 or 707.07) is specified, the Contractor may furnish conduit with a coating conforming to 707.04.

611.03 Definitions. The following terms, when used in this specification, are defined as follows:

Backfill. Material used to fill the trench or excavation, further defined as Structural Backfill and Final Backfill, not including the bedding material.

Bed. The bottom of the trench or excavation.

Bedding Material. Material placed above the bed and below the conduit or drainage structure.

Conduit. Includes pipe, culverts, sewers, and drains. Conduits are classified as Type A, B C, D, E, and F.

Conduit Rise. The distance of the greatest vertical opening of the conduit. For round conduits, the conduit rise equals the conduit diameter.

Corrugated Metal Conduit. Includes all conduit made from corrugated steel or corrugated aluminum. Either material may also have coatings. This includes all of the following types of materials: 707.01, 707.02, 707.03, 707.04, 707.05, 707.07, 707.11, 707.12, 707.13, 707.14, 707.15, 707.17, 707.21, 707.22, 707.23, 707.24, and 707.25.

Cut. A situation where the top of the conduit is below the existing ground surface or where a proposed embankment is constructed at least 2 feet (0.6 m) above the top of the conduit before installation.

Deflection. Uniform or symmetrical flattening or ovalization of the pipe's cross-section.

Drainage Structures. Manholes, catch basins, inlets, inspection wells, junction chambers, and precast reinforced concrete outlets.

Fill. A situation where the top of the conduit is above the existing ground surface in an area where an embankment will be constructed.

Final Backfill. Material used to fill the trench or excavation above the Structural Backfill.

Flexible Conduit. Plastic, corrugated metal, ductile iron (748.01), or steel casing pipe (748.06).

Infiltration. Water or other material that enters the conduit or drainage structure through the joints or conduit connections in excess of the limits for soil tightness or for the type of joint specified.

Lay Length. The length of a standard section of pipe as normally supplied by the manufacturer.

Material Durability Design. Empirical design method used to ensure a 75-year average service life due to conduit material degradation caused by water chemistry and suspended material abrasion.

Plastic Conduit. Corrugated polyethylene, polyvinyl chloride, or ABS conduit. This includes all of the following types of materials: 707.32, 707.33, 707.41, 707.42, 707.43, 707.44, 707.45, 707.46, 707.47, 707.51, 707.62, 707.65, 707.69, 707.85, and 748.02.

Racking. Non-symmetrical deflection or ovalization of a pipe's cross-section.

Rigid Conduit. Concrete pipe, vitrified clay pipe, or clay drain tile. This includes all of the following types of materials: 706.01, 706.02, 706.03, 706.04, 706.05, 706.051, 706.052, 706.053, 706.08, and 706.09.

Run of Conduit. The conduit placed between drainage structures, between a drainage structure and an open outlet, between an open inlet and a drainage structure, or between the open inlet and open outlet.

Span. Span is the conduit opening measured along the centerline of the roadway.

Spring Line. A line along the length of the pipe at its maximum span. For circular pipes the spring line is located at mid-height of the pipe (rise divided by two).

Structural Backfill. Material adjacent to the conduit used to fill the trench from the top of Bedding Material to 12-inches above the top of conduit or greater as required by the manufacturer. For drainage structures, material used to fill the trench from the top of Bedding Material to subgrade in pavement or topsoil in vegetated areas.

611.04 Submittals

A. Shop Drawings. Prepare and submit shop drawings for C&MS items 706.051, 706.052, 706.053. Submit calculations for C&MS items 706.051, 706.052, 706.053 and all conduit materials as required below. Have competent individuals prepare and check the shop drawings and required calculations. Provide a cover sheet containing the preparer(s) and checker(s): First Name, Last Name, Initials and Content Responsibility. Preparer(s) and checker(s) shall initial each sheet for their content responsibility. The preparer(s) and checker(s) shall not be the same individual. Have an Ohio Registered Engineer review, approve, sign, seal and date the shop drawing cover sheet or submittal letter and hydraulic calculations according to ORC 4733 and OAC 4733-35.

1. Submit load rating report in accordance to the most current version of ODOT's Bridge Design Manual along with one copy of the shop drawings and one copy of the calculations to the Office of Structural Engineering for all structures with a 10 foot or larger span. Submit an additional copy of the shop drawings and calculations to the Engineer.

2. If Reinforced Concrete Circular Pipe 706.02, requires a special structural design with a specified D-load requirement other than Tables 706.02-1 through 706.02-4, submit special structural design calculations. Design the pipe to meet the D-load requirements. Include the following information in the submittal: all structural design and loading information, all material specifications, all dimensions, and the installation plan.

3. Submittals for Precast reinforced concrete 3-sided flat topped culverts, precast reinforced concrete arch sections, or precast reinforced concrete round sections, (706.051, 706.052, or 706.053) shall include structural analysis methods, structural design criteria and calculations, structure details, and shop drawings. Include details for a precast slab bottom if required.

4. To substitute a precast reinforced concrete 3-sided flat topped culvert (706.051), a reinforced concrete arch section (706.052), or a precast reinforced concrete round section (706.053) for one another, the submittal shall include hydraulic calculations. The proposed culvert shall meet or exceed the same hydraulic requirements as the specified culvert and minimum cover requirements. If the specified culvert is on pedestal walls, include the shop drawings for the pedestal wall design in the submittal because 3-sided flat topped culverts, arch culverts, and round sections require different pedestal wall designs.

5. To substitute either a precast reinforced concrete 3-sided flat topped culvert, a precast reinforced concrete arch section, or a precast reinforced concrete round section (706.051, 706.052, or 706.053) placed on a precast or cast-in-place slab bottom for a precast reinforced concrete box culvert (706.05), the submittal shall include hydraulic calculations. The proposed culvert shall meet or exceed the same hydraulic requirements as the specified box culvert and minimum cover requirements. The Department may allow the bottom slab to be cast-in-place but will not issue a time extension for any delays resulting from the use of a cast-in-place bottom slab.

Department approval of shop drawings and calculations is not required.

B. Installation Plan. Submit a written installation plan to the Engineer for installing all conduit and drainage structures for review and acceptance.

Submit the installation plan at least 15 days before any conduit or drainage structure work begins.

Do not perform work without an accepted installation plan.

Include the following required information for each conduit run:

1. Completed CA-P-1A Conduit Installation Plan Form dated 07-16-21.

2. Trench and excavation cross-sections with dimensions.

3. Bedding and Backfill material types with compaction density or compacted depth.

4. Plan and allowed buried height of cover.

5. Other installation details as necessary.

6. Provide written confirmation from the conduit manufacturer that the conduit material with the Bedding and Backfill types and compaction as described in the CA-P-1A Installation Plan Form will perform structurally for the location. This confirmation by the conduit manufacturer will not relieve the Contractor of the responsibility for obtaining the required results.

Include the following required information for each drainage structure:

1. Completed CA-P-3A Drainage Structure Installation Plan Form dated 07-16-21.

2. Trench and excavation cross-sections with dimensions.

3. Bedding and Backfill material types with compaction density or compacted depth.

4. Other installation details as necessary.

Submit any deviations from the installation plan prior to commencing with the Work. Resubmit all installation plan revisions and applicable special structural design calculations to the Engineer within 14 days of the change with the conduit manufacturer's written confirmation as described above. Do not perform conduit or drainage structure Work without an updated, manufacturer signed and accepted installation plan.

For structural plate and metal pipe arch conduit with a span of 57 inches (1440 mm) or larger, ensure the manufacturer provides match-marked ends on the conduit. Include a layout drawing in the installation plan.

For metal conduit with two structural plate thicknesses specified, identify the location of the thicker plates. For precast concrete 3-sided flat and arch topped structures (706.051 and 706.052) provide a 3 inch (75 mm) deep keyway centered on the leg and at least 6 inches (150 mm) wider than the thickness of the leg at the bottom. For precast concrete round sections (706.053) provide an 8 inch (200 mm) deep keyway for spans up to 24 feet (7.3 m) and a 10 inch (254 mm) deep keyway for spans greater than 24 feet, (7.3 m). Center the keyway on the precast arch base. The width of the keyway must be 8 inches (200 mm) greater than the thickness of the precast arch base. For non-vertical leg arches set on pedestal walls, a one sided keyway is acceptable if the required pedestal wall design thickness is not sufficient for a full keyway.

C. Construction Inspection Forms. Perform work so that it can be verified by the Contractor's representative performing the inspection. Notify the Engineer in writing at least 14 days prior to beginning the work. Submit construction inspection forms to the Engineer for each run of conduit and each drainage structure. Use construction inspection form CA-P-1 for conduit and use construction inspection form CA-P-3 for drainage structures. Inspection form CA-P-3 is not required for precast reinforced concrete outlet structures 706.15. Ensure that all deviations from

the installation plan are noted on the construction inspection form. Ensure that the information on the construction inspection form is complete and accurate and that the form is signed by a representative of the Contractor certifying that the information on the form is accurate. The Contractor's representative must make the following statement on the form:

"I certify that the information on this form is accurate and all deviations from the current installation plan have been noted."

Submit each day's construction inspection forms before the start of the next work day. If the Engineer gives notice that the information on the form is incomplete or not accurate, do not continue related work until complete and accurate forms are submitted and accepted by the Engineer.

Construction inspection forms CA-P-1 and CA-P-3 require trench and bedding measurement checks to be taken every 50 feet with a minimum of two per run. Record measurements to the nearest 0.1 foot (30 mm). If these measurements are not taken, do not continue related work until the Contractor submits a plan in writing to the Engineer for approval that explains how these measurements will be determined.

D. Performance Report. Provide a performance report for each performance inspection. Include the following in each performance report:

1. Project number and County-Route-Section.
2. Date of performance inspection.
3. Type and size of conduit.
4. Time of video recording.
5. Location (e.g. station and offset) and viewing direction.
6. Summary of all defects including type, measurement, and location.
7. For remote inspections using a mandrel, indicate in the performance report, the size of the mandrel and how it was calculated. Document all locations where the mandrel was unable to advance through the conduit.
8. For remote inspections using a crawler mounted camera with laser profiler, include:
    a. Three dimensional model of the conduit based on the laser profile measurements.
    b. Digital profile of conduit extracted from the inspection video.
    c. Calculations of the ovality, capacity and delta of the conduit
    d. Explanation as to why data was unattainable for any section of the conduit.
9. Conduit Evaluation

Submit a performance report to the Engineer within 14 days of completing the performance inspection of the conduit run or drainage structure. Submit the

performance report in a digital format that allows the Department to make additional copies.

611.05 Excavation. Excavate as described in the installation plan. Record any deviations from the installation plan on the construction inspection forms and revise the installation plan.

Excavate trenches along the centerline of the conduit. When installing conduit in a fill situation, construct the embankment to the elevation of the spring line for the conduit or higher before excavating the trench.

Provide a firm bed for the full width and length of the trench for conduits and drainage structures. Remove any unsuitable material exposed in the bed for the width of the trench and a depth of at least 6 inches (150 mm). Replace the unsuitable material with structural backfill, Type 1 or 2. Remove any rock or shale exposed in the bed to a depth of at least 6 inches (150 mm). Replace the rock or shale with Structural Backfill, Type 1 or 2. The Department will pay for this work according to 109.05, unless otherwise noted in the Contract Documents. If the Engineer changes the flow line by more than one foot (0.3 m), the Department will pay according to 109.05, unless otherwise noted in the Contract Documents.

611.06 Bedding and Backfill. Place and compact bedding and backfill as described in the installation plan. Record any deviations from the installation plan on the construction inspection forms and revise the installation plan.

Place geotextile fabric, Type A above coarse aggregate backfill for the full width of the trench. For installations where groundwater is probable, wrap coarse aggregate bedding and backfill with geotextile fabric to the elevation or above the elevation of the the groundwater. Shape the bedding with recesses to receive the bell of bell-and-spigot conduit. Loosen the bedding in the middle third to seat the conduit. If using LSM for bedding, also use LSM for backfill to at least 6 inches (150 mm) over the top of the conduit. Install bedding and backfill for Type F conduits for underdrain outlets according to 605.03.C. Conduit Manufactures may approve materials listed in 611.02 for Final Backfill for use as Bedding and Structural Backfill for Type F conduits on slopes 3:1 or greater. Conduit Manufacturers may approve materials listed in 611.02 for Final Backfill for use as Structural Backfill for conduit Types D and E and drainage structures not located in pavement. Identify the use of Final Backfill materials proposed for Bedding and Structural Backfill in the Installation Plan and cross-section details.

Vibrate, tamp or compact each Bedding and Backfill lift. Perform compaction density testing of Bedding and Backfill according to Supplement 1015. If Structural Backfill Type 3 or open graded material is used, place the aggregate in lifts not to exceed 12-inches. Measure the Structural Backfill Type 3 compacted lift to ensure consolidation is 85 percent or more of the original lift thickness.

Final Backfill shall meet or exceed the requirements of 203.

611.07 Laying Conduit. Maintain flows and drainage at all times until the new facilities are completed and in service. Any planned temporary diversion of flows and drainage is the responsibility of the Contractor. Maintain temporary diversion at no additional cost to the Department.

Visually inspect all conduit before it is placed in the trench. Replace all conduit that is damaged as determined by the Engineer. Before installation, measure and record on the CA-P-1 the widest inside dimension of each lay length of conduit. This measurement is to be taken three times along each run of conduit. For corrugated metal conduit measure to the inside peak of the corrugations.

Lay the conduit in the center of the trench at the invert elevation shown on the plans. Any deviation must be approved by the Engineer. If the Engineer does not approve the deviation, stop all related work until the conduit is relaid. Ensure that the conduit is in contact with the bedding for its full length and maintain the line and grade of the conduit. The Contractor's representative doing the inspection will visually inspect all conduit before placing any backfill. Rejoin, re-lay, or replace conduits that have settled, or that are damaged.

Lay all conduits as described in the installation plan and according to the following requirements. The installation plan cannot change the following requirements. Meeting these requirements does not relieve the Contractor of the responsibility for obtaining the required results. Record any deviations from the installation plan on the construction inspection forms and revise the installation plan.

A. If the welded seam in a metal conduit is longitudinal, place the seam at the spring line.

B. For all metal conduit, use only lifting devices that do not require a hole through the material.

C. Lay metal conduit so that match marks align.

D. For all metal conduit that is cut at a drainage structure or headwall, treat the cut end with the same coating as the conduit. Do not treat any cuts within the run.

E. Where two structural plate thicknesses are specified, place the thicker plates according to the installation plan.

F. Set precast reinforced concrete 3-sided flat topped culvert sections (706.051) in the keyway. Place the units in a 1/2 inch (13 mm) bed of mortar. If proper line and grade of the structure cannot be maintained on the bed of mortar, set the sections on 5 × 5 inch (125 × 125 mm) masonite or steel shims. Fill the entire keyway joint with mortar.

G. Set precast reinforced concrete arch sections (706.052) in the keyway. Place the units on 5 × 5 inch (125 × 125 mm) masonite or steel shims to provide a minimum 1/2 inch (13 mm) gap between the footing and the bottom of the leg. Fill the entire keyway joint with mortar.

H. Set the precast reinforced concrete round sections (706.053) in the keyway. Place the units on masonite or steel shims to provide a minimum 1.5 inch (38 mm) gap between the footing and the bottom of the precast arch base. Fill the entire keyway joint with mortar. Provide 5000 psi. (34.5 MPa) mortar. For arches that gain structural continuity by a cast-in-place closure at the project site, provide concrete with the same compressive strength as the precast arch.

I. For precast reinforced concrete culverts (706.05, 706.051, 706.052, and 706.053) fill the lifting devices with mortar. Cover the exterior of the lifting devices

with joint-wrap material if they are outside the limits of the membrane waterproofing. Use joint-wrap with a minimum width of 9 inches (225 mm). Use only lifting devices that do not require a hole through the structure.

J. The inlet of all rigid conduit used in a Type A application (open inlet) must have a bell. If field cutting is necessary to furnish a bell at the inlet, locate the cut end at an interior joint by removing part of a section within the run. Join the conduit as described below and encase the joint with a concrete collar to ensure a stable connection.

K. The top and bottom of reinforced concrete pipe that has elliptical or quadrant mat reinforcing will be clearly marked on the pipe. Handle and place this pipe so that the markings remain in a vertical plane through the center of the pipe.

L. Handle and place reinforced concrete pipe with auxiliary reinforcements (stirrups) with the centerline of the auxiliary reinforcement system (stirrups) in a vertical plane through the center of the pipe.

M. Fill all lifting holes in rigid conduit with concrete according to the manufacturer's recommendations or using a method approved by the Engineer.

N. Immediately after placing conduit, construct the end treatments at both the outlet and inlet ends. Show this activity as part of the conduit construction on the progress schedule. These end treatments include headwalls, concrete riprap, rock channel protection, sod or other erosion control items.

O. When conduit is installed under pavement, perform the following immediately after the completion of backfill placement and compaction: remove and dispose of all surplus material according to 105.17, clear the site, and replace all pavement necessary to restore traffic. Show this activity as part of the conduit construction on the progress schedule.

P. Lay all conduit from outlet end to inlet unless approved by the Engineer.

611.08 Joining Conduit. Ensure the joints are clean and free from dirt or debris. Join the conduit sections as described below. Visually inspect all conduit, joints, and gaskets before placing any backfill. Rejoin, re-lay, or replace any conduit that does not meet the requirements.

The Engineer may allow joint materials other than those listed below, provided the Contractor demonstrates the proposed material will result in durable, sealed joints.

Join conduit as described in the installation plan and according to the requirements below. Provide a concrete masonry collar per SCD D.M.-1.1 when joining conduits of different materials. For conduit material not listed below, join conduit as recommended by the manufacturer. Record any deviations from the installation plan on the construction inspection forms and revise the installation plan.

A. Corrugated Metal Conduit. Join corrugated metal conduit, Types A, B, C, D, and F, using either coupling bands or bell and spigot joints. Join the conduit according to the following requirements.

1. Coupling bands. Furnish coupling bands conforming to 707.01 or 707.02, and having the same coating as the conduit being joined. Use either coupling bands with gaskets or wrap the joints with geotextile fabric, Type A.

2. Bell and spigot joints. If using bell and spigot joints, place a gasket in the first corrugation of the spigot end and thoroughly lubricate the gasket and the bell end of the receiving conduit before assembly. Drive the spigot securely into the bell.

3. For corrugated metal conduits with smooth steel interior liner, furnish a joint conforming to 707.18, 707.19 and 707.20.

B. Rigid Conduit. Join rigid conduit, Types A, B, C, D, and F, according to the following requirements.

1. For all concrete pipe (706.01, 706.02, 706.04) that is not epoxy coated and vitrified clay pipe (706.08), seal the joints using one of the following methods:

a. Fill the joint with bituminous pipe joint filler, providing a smooth transition on the inside and a complete seal on the outside.

b. Use preformed flexible joint sealant to seal the joint. Before installing the joint sealant, prime both surfaces of the joint with asphalt based primer according to the joint sealant manufacturer's recommendations.

c. Use resilient and flexible gasket joints. If the conduit is a sanitary sewer pipe, test the joint for infiltration and exfiltration according to ASTM C 969 or ASTM C 1103. If any joint does not meet the test requirements, make corrections until the joint meets the test requirements.

2. For epoxy coated concrete pipe (706.03), seal the joint using fibrated coal tar joint compound applied according to the conduit manufacturer's recommendations.

3. For precast reinforced concrete box culverts, precast reinforced concrete 3-sided flat topped culverts, precast reinforced concrete arch sections, and precast reinforced concrete round sections (706.05, 706.051, 706.052, and 706.053), place the sections according to the installation plan. Clean the joint gap of all debris and apply one of the following:

a. For joints in precast reinforced concrete box culverts (706.05), fill the top exterior joint gap and the bottom and side interior joint gap with mortar. Next, cover all exterior joints with a 12 inch (300 mm) wide strip of joint wrap in accordance with the joint wrap manufacturer's recommendation. Center the joint wrap on the joint.

b. For precast reinforced concrete 3-sided flat topped culverts (706.051), fill the top keyway joint with nonshrink mortar. If the side or leg joints are tongue and groove types, fill the joints as described above for concrete box culverts. If the side or leg joints are keyway types, fill with nonshrink mortar. Prepare, place, and cure the nonshrink mortar according to the nonshrink mortar manufacturer's recommendations. Wet all surfaces of the keyway joint, but do not allow free standing water in the joint. Next, cover the exterior joint with a 12 inch (300 mm) wide strip of joint wrap. Center the joint wrap on the joint. Use a

continuous length of joint wrap sufficient to extend from the bottom of the vertical face on one side to the bottom vertical face on the other side. Apply membrane waterproofing to the precast sections after they are installed.

c. For precast reinforced concrete arch sections and precast reinforced concrete round sections (706.052 and 706.053), install a 7/8 x 1 3/8 inch (24 x 34 mm) preformed flexible joint sealant (706.14) along the outside joint chamfer. Use a continuous length of joint sealant sufficient to extend from the bottom of the vertical face on one side to the bottom vertical face on the other side. Before installing the joint sealant, prime the joint chamfer with a primer according to the joint sealant manufacturer's recommendations. For 706.052 and 706.053, cover all exterior joints with a 12 inch (300 mm) wide strip of joint wrap centered on the joint. Use a continuous length of joint wrap sufficient to extend from the bottom of the vertical face on one side of the structure to the bottom vertical face on the other side. Next, apply all waterproofing as shown on the plans. Apply membrane waterproofing to the precast sections after they are installed.

4. For precast reinforced concrete box culverts, precast reinforced concrete 3-sided flat topped culverts, precast reinforced concrete arch sections, and precast reinforced concrete round sections (706.05, 706.051, 706.052, and 706.053), apply an approved epoxy-urethane sealer per the plans to all top surfaces not covered by membrane waterproofing. Extend sealer 1 foot (0.3 m) below the backfill on all sides of the culvert sections including the joint.

C. Plastic Conduit. Join plastic conduit, Types A, B, C, D, and F, using either coupling bands, bell and spigot joints, or bell-bell couplers. Join the conduit according to the following requirements.

1. Coupling bands. Furnish coupling bands of the same size as the conduit and that engage at least two full corrugations on each conduit section. Furnish gasketed coupling bands of the same material as the plastic conduit.

2. Bell and spigot joints. If using bell and spigot joints, drive the spigot securely into the bell. For gasketed joints, ensure that the gasket is properly seated after joining.

3. Bell-bell couplers. If using bell-bell couplers, drive the conduit securely into the coupler.

D. Type E Conduit. Join Type E conduits with open joints by butting the ends and wrapping with a minimum 4 inch (100 mm) wide tarred paper or tarred burlap. Place soil around this material to hold it in place during backfilling.

611.09 Exterior Coatings and Membrane Waterproofing. Apply exterior coatings and membrane waterproofing as specified below. Protect the exterior coatings and membrane waterproofing from damage during placing of the bedding, backfill, and embankment.

A. For 611.08.B.3. concrete conduit, clean the surfaces before placing the membrane waterproofing. Apply membrane waterproofing as specified. Apply the membrane waterproofing to all surfaces that will be in contact with the backfill (top and sides) according to the membrane waterproofing manufacturer's recommendation.

B. For structural plate metal structures and corrugated metal box culverts (707.03, 707.15, 707.23, and 707.25), apply waterproofing by one of the following methods.

1. Coat the exterior of the conduit above the limits of the bedding and within the limits of backfill. Ensure that all plate seams and bolts are thoroughly sealed. Furnish coating material and apply it according to AASHTO M 243. Allow asphalt mastic material to dry 48 hours and tar base material to dry 28 hours before placing the conduit backfill. Rib stiffeners do not need to be coated.

2. Construct buried liner waterproofing membrane protection in the fill according to the manufacturer's recommendations. The buried liner waterproofing membrane protection must be a continuous sheet placed over the conduit and extend at least 10 feet (3.3m) outside of the paved shoulder and for the width of the trench. Seams constructed in the field are not acceptable.

611.10 Drainage Structure Construction. Install drainage structures as shown on the plans and standard construction drawings. Maintain flows at all times until the new facilities are completed and in service.

Visually inspect all precast drainage structures before they are placed. Replace all drainage structures that are damaged as determined by the Engineer.

Install each drainage structure casting to the elevation, station, and offset shown on the plans. Any deviations must be approved by the Engineer. If the Engineer does not approve the deviation, stop all related work until the drainage structure is reinstalled. The offset is to the center of the casting. Place each manhole base so that it is in alignment with the pipe and its invert elevation according to the standard construction drawings. Use flat slab top manholes as shown on the standard construction drawing. Do not remove the flat slab top manhole lifting devices.

Locate or cut conduits so any protrusion inside the structure wall is minimized.

Set iron frames, tops, and covers in mortar with a flush joint.

Prevent earth or debris resulting from construction operations from entering the drainage structure. Remove any debris resulting from construction.

Thoroughly grout the underdrain outlet pipe to the precast reinforced concrete outlet with a flush mortar joint.

Take adequate precautions to prevent concrete or mortar from freezing. Preheat the brick, concrete block, or precast concrete structure throughout the entire mass to a temperature between 50 to 80 °F (10 to 27 °C) before placing mortar if the ambient temperature is 40 °F (4 °C) or less.

A. Brick and Block Masonry. For brick and block masonry drainage structure construction thoroughly wet the units before placing in mortar. Lay the units with a flush mortar joint. Cure the exposed surfaces of all brick and block masonry by covering with wet burlap or by applying a curing membrane according to 705.07. Keep burlap wet for at least 48 hours.

B. Modular Precast Concrete. For precast concrete modular drainage structures furnish precast bases on a compacted bed with or without a bedding material as described in the installation plan. Ensure that the bed is level and

uniformly supports the entire area of the base. Seal all joints between modules as described above for concrete conduit.

All penetrations through precast drainage structures must be either manufactured or cored.

After placing the conduit, grout all openings less than 4 inches (100 mm) between the pipe and structure with mortar. Grout all openings greater than 4 inches (100 mm) between the pipe and structure with non-shrink mortar. Furnish the same curing membrane for barrier inlets as that used on the barrier. Apply the curing membrane according to 622.07.

C. Reconstruction to grade. When reconstructing an existing manhole, catch basin or inlet to grade, follow the procedure below.

1. Carefully remove and clean the existing castings.

2. Remove the existing walls of manholes down to the spring line of the conduit or below as necessary. Remove existing walls of catch basins and inlets below the window openings, grates, or any points of wall failure.

3. Using the salvaged casting, reconstruct the structure to the new grade, conforming as nearly as practicable to the existing dimension and type of construction.

D. Adjustment to grade. When adjusting an existing manhole, catch basin, or inlet to match grade, follow the procedure below.

1. Carefully remove and clean the existing frame, adjust the height of supporting walls, and reset the existing frame in mortar or concrete to the new grade.

2. Carefully remove the existing cover or grate and install a casting or an acceptable adjusting device on file at the Laboratory or an adjusting device approved by the Engineer to the new grade and install according to the adjusting device manufacturer's recommendations.

611.11 Field Paving of New or Existing Conduit. Field pave the bottom of the conduit with concrete as shown on the plans. Installation Plans are not required for field paving of existing conduits. Include any field paving details in the Installation Plan for all new conduit.

For new pipe installations, do not pave until at least 4 feet (1.2 m) of fill is placed on top of the conduit or the top of subgrade is reached. If the paving is placed before completion of the entire fill, clean any gaps between the conduit and concrete paving, and then fill with heated bituminous material conforming to 705.04.

Reinforce the paving with 2 x 2-W0.9 x W0.9 galvanized welded wire fabric or epoxy coated reinforcing steel meeting the material requirements of 509.02. Provide galvanized wire fabric or epoxy coated reinforcing steel with a width 4 inches (100 mm) less than the finished paving. Provide support beneath the mesh where necessary using galvanized support chairs or #4 epoxy coated reinforcing steel. Securely fasten the mesh to the conduit near each edge and at the center of the mesh at points not more than 4 feet (1.2 m) apart along the flow line of the culvert. Securely fasten the epoxy coated reinforcing steel to the conduit at each end and along the length of the steel not more than 4 feet (1.2 m) apart. Repair any damage

to the galvanizing or other coating material caused by placement or by tack welding. Use wire brushing and zinc rich paint to make the repairs.

For all aluminum conduits, prior to placing concrete, coat the area to be paved with a zinc chromate primer or an epoxy paint formulated for applying to aluminum. Extend primer or epoxy 4 inches beyond the proposed paving limits. For aluminum structural plate, securely fasten the mesh to the circumferential seam bolts with galvanized tie wire.

Construct paving so that it is 3 inches (75 mm) thick measured from the top of the corrugations of the conduit to a height equal to 1/3 of the Conduit Rise. Maintain the position of the mesh while placing concrete. After placing the concrete, strike it off with a template to produce the proper radius, and finish with a float to produce a smooth finish. Cure the concrete according to 451.11.

When field paving existing conduits, maintain flows in accordance with 611.07.

When standing water is encountered and cofferdams are necessary, construct and pay for cofferdams per Item 503.

611.12 Performance Inspection. Notify the Engineer at least five workdays before conducting a performance inspection. Ensure the Engineer is present during all performance inspection activities.

For all Type A, B, and C conduits, inspect all lengths greater than 20 feet with slopes of 25 percent or less and all new drainage structures. Performance inspections are not required for all Type D, E and F conduits. A performance inspection is not required for projects that meet all of the following:

All conduit is Type C

Conduit plan quantities are less than 100 feet (30.5m)

All conduit has less than 16 feet (4.8m) of maximum fill height

In each phase of construction of a conduit, perform the inspection no sooner than 30 days and no later than 90 days after the completion of the finished grade when not below pavement and after the completion of the rough subgrade when any portion of the conduit is below pavement. The Engineer may permit inspection beyond the 90 day limit. If any corrections are made to the installed pipe after the completion of the finished grade or rough subgrade and prior to the performance inspection, wait 30 days after the correction was made to do the performance inspection. If the contract duration will not permit a 30 day waiting period then the Engineer may adjust the waiting period.

Visually inspect for surface settlements within the trench limits or within 4 feet of a drainage structure. Document all locations of surface settlement in the inspection report.

Furnish a video recording of all conduit and drainage structure inspections. On the recording, identify the date and time of the inspection, a description of the conduit or drainage structure being inspected, the location, and the viewing direction. Record the entire run of conduit being inspected. Provide a source of light that allows all areas of concern to be readily observed on the video recording. Furnish the video recording in a digital, reproducible format on one of the following

media types: Portable hard drive, flash drive or as determined appropriate by the Engineer. Provide the video files with a naming format consistent with the Installation Plan references or as determine acceptable by the Engineer.

Ensure that the condition of the conduit will allow an accurate inspection. Perform a manual inspection on drainage structures. Perform either a manual inspection or remote inspection as follows:

Non-circular conduits	Manual inspection
Conduits with a rise of 48 inches (1.2 m) and greater	Manual inspection
Conduits with a rise of 36 inches (900mm) up to 48 inches (1200mm)	Manual or Remote inspection
Conduits with a rise of 12 inches or greater up to 36 inches (300 to 900 mm)	Remote inspection

Conduits with a rise less than 12 inches (300 mm) and Type D, E, and F conduits – Remote inspection as directed by the Engineer. The Department will pay for this inspection according to 105.10.

A. Manual Inspection. Perform a manual inspection by entering the conduit or drainage structure to record video and to make measurements. If the conduit or drainage structure is considered a confined space, provide entry for all project inspection personnel according to OSHA requirements.

Measure the deflection of the conduit using either a metal tape, fabric tape or equipment accepted by the Engineer and read to the nearest ½ inch (10 mm). Measure crack width using either a crack comparator or a feeler gage capable of measuring 0.01 inch (0.25 mm). Measure joint gaps using a tape or ruler and read to the nearest ½ inch (10 mm). Other measuring devices may be used if approved by the Engineer. Record the measurements and include them in the performance report. Measure the following:

1. For all conduits, measure the location, length, and greatest width of each crack.

2. For flexible conduit, measure the smallest inside diameter three times for each conduit section in the run. Take the first measurement vertically from the crown to invert (12 o'clock to 6 o'clock positions). Take the second measurement by rotating 60 degrees from vertical (2 o'clock to 8 o'clock positions). Take the third measurement by rotating 120 degrees from vertical (4 o'clock to 10 o'clock positions). For all measurements, stretch tape to full extent across inside of pipe. For corrugated metal conduit, the inside diameter is defined as the distance between the inside peaks of the corrugations.

3. For all conduits, measure the widest gap at each joint in the run.

4. For conduit with manufactured seams, measure the location, length, and greatest width of any separation at the seam.

5. For drainage structures, measure the location, length and greatest width of each crack and the widest gap at each conduit entering the drainage structure.

Record the location of any other defect not listed above and describe the defect. For each measurement location in a conduit, record the length from the nearest drainage structure.

B. Remote Inspection. Perform a remote inspection by using a crawler mounted camera to record video and using equipment described below to make measurements. Use equipment that meets the requirements of Supplemental Specification 902 (SS902). Remove all debris from the conduits being inspected according to 107.19. Dewater the conduit if the water level hinders the performance of the equipment.

Based on the type of conduit, make measurements using the equipment listed in the following table. Also record the location of any other defect not listed below and describe the defect.

TABLE 611.12.B

Conduit Type	Measurement Equipment	Type of Measurement
Rigid conduit and 748.06, steel casing pipe	Crawler mounted camera according to SS902.01with crack measuring capabilities according to SS902.02 C	Joint gaps Crack widths
Plastic conduit, 707.12, corrugated steel spiral rib conduit, 707.24, corrugated aluminum spiral rib conduit, 748.01, ductile iron pipe, and Circular corrugated metal conduit not listed below	Crawler mounted camera with laser profiler according to SS902.02 A, B, and C or Mandrel according to SS902.03 and Crawler mounted camera according to SS902.01 with crack measuring capabilities according to SS902.02 C	Joint gaps Crack widths Deflection
The following types of corrugated metal conduit: 707.04, precoated, galvanized steel culverts 707.05 and 707.07, bituminous coated corrugated steel pipe with paved invert, 707.11 Polymer-precoated corrugated steel spiral rib pipe 707.13 and 707.14, bituminous lined corrugated steel pipe	Crawler mounted camera with laser profiler according to SS902.02 A, B, and C	Joint gaps Crack widths Deflection

611.13 Conduit Evaluation. Have an independent Registered Engineer review the conduit Performance Inspection and provide a written documentation of whether defects listed in Table 611.13 are present or not. Record any other identified defects present in the conduit. Evaluate the defects to ensure structural stability and

hydraulic capacity are in conformance with the contract documents and as prescribed by AASHTO LRFD Bridge Construction Specifications, Section 26 for metal conduit, Section 27 for concrete conduit, and Section 30 for plastic conduit with modifications according to this specification. Provide written documentation of evaluations performed of all defects and any recommended repairs to the Engineer. The independent Registered Engineer cannot be an employee of the Contractor or the conduit manufacturer.

When using a laser profiler, the conduit deflection must be calculated from the actual inside diameter at the measured location or calculated by inputting the nominal diameter. When using a mandrel, the mandrel must be sized according to 902. If the evaluation determines repairs are not necessary and repairs are not required based on the type or size of the defect in Table 611.13, have the independent Registered Engineer make the following statement in the evaluation:

"I certify that repairs are not required to address the defects identified during the conduit evaluation. The conduit will function in accordance with the contract documents."

If the evaluation determines repairs are necessary, or if repairs are required based on the type or size of the defect in Table 611.13, have the independent Registered Engineer prepare, sign, seal, and date plans for the repair. The independent Registered Engineer must make the following statement on the repair plans:

"I certify that this repair plan was designed to ensure the repaired conduit will function structurally and provide hydraulic capacity in accordance with the contract documents."

TABLE 611.13

Metal Conduit	Evaluate if infiltration is observed. Evaluate all racking, buckling or denting. Evaluate all vertical sags or misalignments exceeding 0.1 ft. Repair or replace vertical sags or misalignments of 0.25 ft and greater. Evaluate the overall vertical alignment of the conduit recorded in CA-P-1. Evaluate if the joint gap exceeds the Manufacturer's tolerance*. Repair or replace conduit if the joint gap exceeds the Manufacturers tolerance*. Repair all damage to coatings. Repair or replace conduit if the Performance Inspection per 611.12 indicates a deflection > 7.5%. Replace conduit if the Performance Inspection per 611.12 indicates a deflection > 12%
Rigid Conduit	Evaluate if infiltration is observed. Evaluate if joint gap exceeds the Manufacture's tolerance*. Evaluate all vertical sags or misalignments exceeding 0.1 ft. Repair vertical sags or misalignments of 0.25 ft and greater. Evaluate the overall vertical alignment of the conduit recorded in CA-P-1. Repair or replace conduit if the joint gap exceeds the Manufacturers tolerance* . Repair or replace conduit if cracks > 0.10 inch. Repair or replace conduit if spalls or slabbing are observed.
Plastic Conduit	Evaluate if infiltration is observed. Evaluate all racking, bulging or buckling. Evaluate if joint gap exceeds the Manufacturers tolerance*. Evaluate all vertical sags or misalignments exceeding 0.1 ft. Repair vertical sags or misalignments of 0.25 ft and greater. Evaluate the overall vertical alignment of the conduit recorded in CA-P-1. Evaluate all cracks. Repair or replace conduit if the joint gap exceeds the Manufacturer's tolerance*. Repair or replace conduit if Performance Inspection per 611.12 indicates a deflection > 7.5%. Replace conduit if the Performance Inspection per 611.12 indicates a deflection > 12%

* Note: The tolerance is defined as the maximum joint gap listed in the Installation Plan.

Submit the evaluation, repair plans, and revised installation plan to the Engineer at least 7 days before performing the repairs. Provide written confirmation from the conduit manufacturer that the repair methods are appropriate. The Department may review the submittal, but Department acceptance is not required. If the Department does not review the plan, proceed with the repairs 7 days after delivering the submittal to the Engineer. If the Department reviews the submittal and determines it does not conform to the Contract, revise, resubmit, and proceed with the repairs only after the Department accepts the resubmittal.

Perform the repair at no additional cost to the Department. Perform an inspection to evaluate the repaired portion of the conduit and any conduit potentially affected by the repair work 30 days after the repair has been made. Perform the inspections according to 611.12 and at no additional cost to the Department. Have an independent Registered Engineer evaluate the inspection according to 611.13 and at no additional cost to the Department.

611.14 Drainage Structure Evaluation. Have an independent Registered Engineer evaluate the drainage structures and provide a written documentation of whether defects listed in Table 611.14 are present or not. Record any other identified defects present in the drainage structure. Evaluate all identified defects to ensure structural stability and hydraulic capacity are in conformance with the contract documents. Provide written documentation of evaluations performed of all defects and any recommended repairs to the Engineer. The independent Registered Engineer cannot be an employee of the Contractor or drainage structure manufacturer.

TABLE 611.14

Defects requiring evaluation
Connection between conduit and drainage structure has free flowing water, infiltration or has not been constructed in accordance with 611.10.
Grate is more than 0.1 ft (30 mm) from horizontal or vertical location documented on construction inspection form CA-P-3.
Invert elevation is more than 5 percent of the conduit diameter or 0.1 ft (30 mm) from plan elevation, whichever is greater as documented on construction inspection form CA-P-1
Grates do not properly seat in the frame.
Grates are not placed on the required slope.
Grates or frames are broken or cracked.
Drainage structure does not match the details on the standard construction drawing.
Steps do not line up.
Manhole top does not match plans.
Conduit connections are not fully grouted per 611.10
Conduits protrusions are present

If the evaluation determines repairs are not necessary, have the independent Registered Engineer make the following statement in the evaluation:

"I certify that repairs are not required to address the defects identified during the drainage structure evaluation. The drainage structure will function in accordance with the contract documents."

If the evaluation determines repairs are necessary have the independent Registered Engineer prepare, sign, seal, and date plans for the repair. The independent Registered Engineer must make the following statement on the repair plans:

"I certify that this repair plan was designed to ensure the structure will function structurally and provide hydraulic capacity in accordance with the contract documents."

Perform the repair at no additional cost to the Department. Perform an inspection to evaluate the repaired portion of the drainage structure and any conduit potentially affected by the repair work 30 days after the repair has been made. Perform the inspections according to 611.12 and at no additional cost to the Department. Have an independent Registered Engineer evaluate the inspection according to 611.14 and at no additional cost to the Department.

611.15 Surface Settlements. Repair any surface settlement within the trench limits or within 4 feet (1.2 m) of a drainage structure. Have an independent Registered Engineer evaluate the conduit according to 611.13 or the drainage structure according to 611.14. Perform all repair work at no additional cost to the Department.

611.16 Method of Measurement. The Department will measure conduit by the number of feet (meters), measured from center-to-center of small drainage structures or between open ends including the length of pipe bends and branches. The Department will not deduct conduit length for catch basins, inlets, or manholes where the distance measured in the direction of flow, including bends, is 6 feet (2 m) or less. Where the location of a drainage structure or an open end is changed with the approval of the Engineer to accommodate full conduit sections, the Department will measure the length placed. Conduits placed on slopes steeper than 3H:1V or with beveled or skewed ends will be measured along the invert.

The Department will measure field paving of existing pipe by the number of feet (meters).

The Department will measure Manholes, Inlets, Catch Basins, Inspection Wells, Junction Chambers, and Precast Reinforced Concrete Outlets, whether new, reconstructed, or adjusted to grade, by the number of each type of structure complete and accepted.

611.17 Basis of Payment. Payment for all inspections is included with the contract unit price of the corresponding pay item. When a pay item calls for concrete encasement, the Department will pay for furnishing and placing the concrete encasement and for any additional excavation required under the contract unit price for the encased conduit. When a pay item calls for conduit to be field paved, all work and materials necessary for the item are included in the contract unit price for each conduit.

All required repairs, including any settlement problems, must be made prior to acceptance. Payment for the repair is included with the contract unit price of the corresponding pay item. The Department will not make additional payment for repair work on conduit installed under this specification.

All conduits and drainage structures installed without required submittals per 611.04 are considered unacceptable materials per 106.07.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
611	Foot (Meter)	___" (___ mm) Conduit, Type ___
611	Foot (Meter)	___ × ___ Conduit, Type ___
611	Foot (Meter)	___" (___ mm) Conduit Reconstructed, Type ___
611	Foot (Meter)	Type ___ Precast Reinforced Concrete Three-Sided Flat Topped Culvert, ___' (___ mm) Span × ___' (___ mm) Rise

611	Foot (Meter)	Type ___Precast Reinforced Concrete Arch Sections, ___' (___ mm) Span × ___' (___ mm) Rise
611	Foot (Meter)	Type ___ Precast Reinforced Concrete Round Sections, ___' (___ mm) Span × ___' (___ mm) Rise
611	Foot (Meter)	___' (___ mm) Rise × ___' (___ mm) Span Conduit, Type A Corrugated Steel Box Culvert, ___' (___ mm) Minimum Cover, ___' (___ mm) Maximum Cover
611	Foot (Meter)	___' (___ mm) Rise × ___' (___ mm) Span Conduit, Type ___Corrugated Aluminum Box Culvert, ___' (___ mm) Minimum Cover, ___' (___ mm) Maximum Cover
611	Foot (Meter)	___" (___ mm) Conduit, Type ___, with Field Paving of Pipe
611	Foot (Meter)	___" (___ mm) Conduit, Type ___, Field Paving of Existing Pipe
611	Foot (Meter)	Conduit, Type F for underdrain outlets
611	Each	Manholes
611	Each	Inlets
611	Each	Catch Basins
611	Each	Inspection Wells
611	Each	Junction Chambers
611	Each	Manhole, Catch Basin or Inlet Reconstructed to Grade
611	Each	Manhole, Catch Basin, or Inlet Adjusted to Grade
611	Each	Precast Reinforced Concrete Outlet

ITEM 613 LOW STRENGTH MORTAR BACKFILL

613.01 Description. This work consists of placing a low strength mortar backfill around conduits and at other locations. Perform the work for this item according to Items 611 and 499, except as modified below.

613.02 Materials. Furnish materials conforming to:

Cement..... 701.01 or 701.04
Fly Ash..... 701.13

Furnish fine aggregate consisting of foundry sand, natural sand, sand manufactured from stone, gravel, or air-cooled blast furnace slag. Conform to the fine aggregate gradation requirements of 703.05. Use fine aggregate that is fine enough to stay in suspension in the mixture to ensure proper flow.

Furnish an air-entraining admixture that is designed for use in low strength mortar mixtures (also called controlled density fill or flowable fill).

613.03 Mix Proportioning. Furnish a low strength mortar mixture listed below or provide an alternate mix conforming to 613.05.

TABLE 613.03-1

	Type 1[1]		Type 2		Type 3	
	lb/yd³	kg/m³	lb/yd³	kg/m³	lb/yd³	kg/m³
Cement	50	30	100	59	0	0
Fly Ash, Class F	250	148	[2]	[2]	1500	890
Fly Ash, Class C [4]	0	0	0	0	297	297
Fine Aggregate [3]	2910	1726	2420	1436	0	0
Water (Target)	500	297	210-300	125-178	850	504

[1] The Contractor may add an air-entraining agent specifically designed for the use in the low strength mortar mixture.
[2] Entrained air is substituted for fly ash in this mix. (Approximately 25 percent)
[3] Saturated Surface Dry
[4] Class C Fly Ash may be substituted for Class F Fly ash in Type 1 mixes with an approved mix design meeting the alternate mix design criteria of this specification.

These mixtures of materials are expected to yield approximately 1 cubic yard (1 m^3) of material of a flowable consistency. Make small adjustments, as necessary, in the amounts of the materials in a mix to achieve the final product.

613.04 Mix Adjustment. Make one or more 1 cubic yard (1 m^3) trial batches at different water contents to ensure a flowable material. The mixture is too dry if cracks develop in the mixture as it flows into place.

Adjust the proportions to maintain the total absolute volume. For large adjustments, see 613.05.

In order to expedite the settlement of a Type 1 mixture without entrained air, bleed water may appear on the surface immediately after the material is struck off. A delay in bleeding indicates there are too many fines in the mixture. The Contractor may reduce the fly ash quantity in increments of 50 pounds (30 kg) until the mixture is bleeding freely. Add approximately 60 pounds (36 kg) of sand to replace each 50 pounds (30 kg) increment of fly ash to maintain the original yield.

613.05 Alternate Mixes. The Contractor may submit alternate mixes for approval. Furnish the mix design and test data from an independent test laboratory 30 days before the intended usage for approval.

Submit an alternate mix design for all mixes that:

A. Vary more than 300 pounds (178 kg) in fine aggregate, 100 pounds (59 kg) in water, 20 pounds (12 kg) in cement, or 200 pounds (119 kg) in fly ash from the 613.03 mixes. These are considered large adjustments.

B. Have less than 50 pounds (30 kg) of cement in the Type 1 mixes or less than 100 pounds (59 kg) of cement in the Type 2 mixes.

C. Use alternate materials.

D. Contain foundry sand.

E. Contain fly ash not conforming to 701.13.

F. Use fine aggregate gradations other than 703.05.

The Contractor may use foundry sand if it meets the requirements of the Division of Surface Water Policy 400.007 "Beneficial Use of Non-Toxic Bottom Ash, Fly Ash and Spent Foundry Sand and Other Exempt Wastes," and all other regulations. Ten days before using a mixture containing foundry sand on the project, submit written permission from the Ohio EPA to the Engineer. The Contractor may elect to have an independent ODOT consultant pre-qualified in remedial design environmental site assessment review the proposed usage. The consultant will provide all documentation utilized to ensure that the proposed usage obeys all Ohio EPA regulations. The consultant shall coordinate all EPA required meetings, documentation, and testing requirements. The consultant shall certify the report or reports to the Department.

Provide alternate mixes with an unconfined compressive strength between 50 and 100 pounds per square inch (345 and 689 kPa) at 28 days when tested according to ASTM D 4832. Ensure that the long term (12 month) unconfined compressive strength is less than 100 pounds per square inch (689 kPa).

Ensure that the final mix has the required strength, fills the voids of the intended usages and sets up within 12 hours (4 hours for Type 3 or Type 3 alternate mixes). The proportioning, yield, consistency, workability, compressive strength, and all other requirements are the sole responsibility of the Contractor.

613.06 Mixing Equipment. Provide the mixing capacity and delivery equipment to place the material without interruption as much as practical. Deliver and place Type 1 and 2 mixes or Type 1 and 2 alternate mixes from ready mixed concrete trucks, or deliver them from a batch plant.

Deliver and place Type 3 mix using volumetric mobile mixers. Calibrate volumetric mixers properly and sufficiently mix the materials in the mixer to produce a uniform material.

613.07 Mixing the Materials. Discharge the mixture within 2.5 hours after adding water.

613.08 Placing Mortar. Unless specifically shown on the plans, do not place the mortar within 3 feet (1 m) of the subgrade elevation. Discharge the flowable material from the mixer by any reasonable means into the space of the plan intended usage. Bring the fill material up uniformly to the fill line shown on the plans. The Contractor may begin placing the other fill material over low strength mortar

backfill material as soon as the surface water is gone. The Engineer reserves the right to reject the mix if a flowable mixture is not produced.

Before placing the low strength mortar backfill as backfill for 611 Conduit, secure the conduit to prevent it from floating during placement of the flowable material.

613.09 Method of Measurement. The Department will measure Low Strength Mortar Backfill by the number of cubic yards (cubic meters) completed and accepted in place, computed from the plan lines. The Department will not pay additional compensation for over excavated areas or for a change in the material blends.

613.10 Basis of Payment. The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
613	Cubic Yard (Cubic Meter)	Low Strength Mortar Backfill
613	Cubic Yard (Cubic Meter)	Low Strength Mortar Backfill (Type ___)

ITEM 614 MAINTAINING TRAFFIC

614.01 Description. This work consists of maintaining and protecting vehicular, bicycle and pedestrian traffic according to these provisions. For through traffic, the Special Provisions or the plans will designate whether the highway will be closed with detours, roads and run-arounds provided or whether traffic will be maintained through all or portions of the project.

614.02 Traffic Facilities. Construct and maintain facilities for vehicular, bicycle, and pedestrian traffic of the highway, including all walks, bicycle lanes, roads, bridges, culverts, and traffic control devices. The Department will maintain public highways used as a detour beyond the work limits of the contract.

A. For local traffic, provide and safely maintain drives, roads, run-arounds, walks, structures, and other facilities. Provide safe vehicular, bicycle, and pedestrian ingress and egress for all property adjacent to any improvement. Provide approaches and crossings of intersecting highways, bicycle lanes, and maintain them in a safe condition. Maintenance includes snow and ice removal as needed.

B. When the highway under construction is being used by through traffic, including periods of suspension of the Work, maintain it so that it is smooth, free from potholes, ruts, ridges, bumps, and other pavement deficiencies. Furnish proper maintenance of traffic facilities and proper provisions for traffic control as per 105.14. For the portions of highway being used, provide the necessary outlets to allow free drainage. Maintain pipe trenches or other openings left in hard surface pavements with material of comparable quality. Contractor maintenance responsibilities, including pothole patching begins for a section of highway when the Contractor begins the Work in that section and ends with the acceptance of the Work under 109.11 or 109.12. The two directions of a divided highway are considered separate highway sections and the start of Work on one direction does not begin maintenance responsibilities on the other direction.

C. Remove from the Project as necessary, abrasives and salt residues left by Department or local government snow and ice control operations.

D. Ensure positive drainage into structures that have inlet windows without grates during pavement overlay operations when traffic will be maintained on a pavement course lower than the inlet window. Provide a minimum of 2 inch (50 mm) holes spaced at 2 feet (0.6 m) or a minimum of three 4 inch (100 mm) holes spaced at 4 feet (1.2 m) drilled into the vertical wall of the existing drainage structure below the inlet window. Place steel or iron plating of at least ¼ inch (6 mm) thickness that completely covers the drilled holes prior to construction of the finished pavement course.

614.03 Traffic Control General. Conform to the requirements of the plan, standard construction drawings shown on the plans, and the OMUTCD, for the installation, maintenance, and operation of all traffic controls and traffic control devices. When the plans or standard construction drawings do not cover a specific traffic control situation, place the necessary traffic control devices according to the OMUTCD and use the procedures required by the OMUTCD.

A. Training and Responsible Person. Ensure all individuals contracted by, secured by, directed by or employed by the contractor whom are involved in the development, design, implementation, operation, inspection and enforcement of work zone related transportation management and traffic control have been trained appropriate to the job decisions each individual is required to make. Repeat training in intervals of no more than 5 years to reflect changing practices.

Designate a trained person at the project level that has the primary responsibility and sufficient authority for implementing and maintaining the

Transportation Management Plan (TMP) and other safety and mobility aspects of the project. For information and requirements regarding TMPs and related components see ODOT Traffic Management in Work Zones Policy (21-008(P)) and Standard Procedure (123-001(SP)). Maintain a 24 hr contact for the designated trained person and provide this contact information to the Engineer at the preconstruction conference. The designated trained person shall be present on site for, and involved with, each temporary traffic control set up/take down and each phase change. For projects with a Worksite Traffic Supervisor (WTS) the designated trained person shall be the WTS.

B. Temporary Traffic Control Devices. Furnish cones, drums, portable sign supports, Type 3 barricades, portable changeable message signs, arrow boards, and impact attenuators that are pre-qualified according to the Department's Approved List.

Furnish cones, drums, signs, sign supports, barricades and other traffic control devices that are certified to meet NCHRP 350 or MASH Test Level 3: Do not use heavy non-yielding devices or supports that are not crashworthy.

For truck-mounted attenuators and trailer attenuators (TMAs) see 614.03.D

Use Type G, H or J reflective sheeting complying with 730.19, 730.192 and 730.193, respectively, for faces of construction signs, barricades, vertical panels, object markers, and stripes on glare screen panels. In addition, the Contractor may also use Type G sheeting referred to as damage control for these devices, provided it meets 730.19.

Use fluorescent orange reflective sheeting for all orange construction signs, object markers, and stripes on glare screen paddles. Use standard orange or fluorescent orange reflective sheeting for the orange portions of drums, cones, barricades and vertical panels.

Furnish orange drums with reboundable reflective sheeting complying with the requirements of 730.191 and in conformance with the OMUTCD. Drums of colors other than orange shall not be permitted on the project. Ensure that owner identification markings on construction drums are no more than 1 inch (25 mm) in character height and are located at least 2 inches (50 mm) below the reflectorized bands or on the top or bottom horizontal surfaces of the drum. Ballast the drums according to the manufacturer's recommendations.

Furnish traffic cones consisting of a highly visible orange predominant color with reboundable reflective sheeting complying with the requirements of 730.191 and in conformance with the OMUTCD. Traffic cones of colors other than highly visible orange shall not be permitted on the project. Ensure that the pavement markings for traffic maintenance conform to Item 640.

Furnish warning signs in advance of channelizing devices such as barricades, drums, vertical panels, and cones.

Furnish object markers that are a minimum size of 6 x 12 inches and that consists of reflective sheeting adhered to an aluminum or plastic plate.

Keep retroreflective materials clean and in good condition.

All temporary traffic control devices shall conform to the Quality Standards for Temporary Traffic Control Devices and Acceptable Delineation Methods for Vehicles.

C. Conspicuity. Equip all vehicles with photo strobe lights, LED warning lights, or rotating beacons meeting Class 1 specifications for color and intensity as defined by the Society of Automotive Engineers (SAE).

Photo strobe lights, LED warning lights, or rotating beacons shall be horizontally visible from all directions (360 degrees) at a distance of 100 feet minimum. In order to ensure this visibility, the light shall in no way be obstructed from view by any signs or appurtenances on the vehicle.

Activate the photo strobe lights, LED warning lights, or rotating beacons and all hazard lights anytime the vehicle is entering, exiting or operating in a traveled lane at a speed less than the posted speed within the limits of the work zone or one mile of either end of the work zone.

In addition, equip all vehicles and trailers having a gross vehicle weight rating of 10,000 pounds or greater, in single or combination, with conspicuity tape. Also, delineate all NCHRP 350 Category IV equipment (arrow boards, portable changeable message signs, etc.) with conspicuity tape.

Conspicuity Tape: Use red and white, Type G, H, or J retroreflective sheeting that complies with 730.19, 730.192, and 730.193.

1. Apply one 2 inch wide (minimum) horizontal stripe of Type G, H, or J retroreflective sheeting to a minimum of 50 percent of the length of each side of the payload portion of the vehicle, rearward from the back of the cab, NCHRP 350 Category IV equipment and trailers. Space lengths of tape evenly over the length of the payload portion of the vehicle rearward from the back of the cab, NCHRP 350 Category IV equipment, and trailers. The centerline for each strip of retroreflective sheeting shall be between 15 inches and 60 inches above the road surface when measured with the vehicle empty or unladen, or as close as practicable to this area.

2. Outline the lower rear facing area of the vehicle, NCHRP 350 Category IV equipment, and trailers with 2 inch wide (minimum) horizontal stripe of Type G, H, or J retroreflective sheeting. Apply the lower horizontal markings extending the width of the vehicle, NCHRP 350 Category IV equipment, and trailer as close as practical to the edge of the vehicle, NCHRP 350 Category IV equipment, and trailer. The centerline for each strip of lower horizontal retroreflective sheeting shall be between 15 inches and 72 inches above the road surface when measured with the vehicle empty or unladen, or as close as practicable to this area.

3. Outline the upper rear facing area with two pairs of strips of 2-inch wide (minimum) retroreflective Type G, H, or J sheeting, each pair consisting of strips 12 inches long, must be positioned horizontally and vertically on the right and left upper corners of the rear of the body of each vehicle or trailer, as close as practicable to the top of the vehicle or trailer and as far apart as practicable. If the perimeter of the body, as viewed from the rear, is not square or rectangular, the strips may be applied along the perimeter, as close as practicable to the uppermost and outermost areas of the rear of the vehicle or trailer on the left and right sides.

Escort transport or delivery vehicles without proper photo strobe lights, LED warning lights, or rotating beacons or conspicuity tape to and from the work zone only with the approval of the Engineer. This exception is intended for limited use at the discretion of the Engineer and will only be considered following a written request by the Contractor. Otherwise, equip all vehicles with photo strobe lights, LED warning lights, or rotating beacons and conspicuity tape as described herein.

Acceptable methods for delineating material supply vehicles are depicted in the Quality Standards for Temporary Traffic Control Devices and Acceptable Delineation Methods for Vehicles.

D. Truck-mounted or Trailer Attenuator (TMA). Furnish a TMA that is NCHRP-350 (manufactured prior to 1/1/20) or MASH TL-3 compliant. Do not use a TMA in place of the arrow board at the beginning of a merge taper, or as a substitute in locations where other positive protection methods are required (portable barrier/impact attenuators, tapering outside of the clear zone, etc.). Use of a TMA for a work area already otherwise protected by positive protection shall be at the Contractor's expense.

Furnish a TMA to protect each work area in the following situations:

1. When working on a multi-lane highway (45 mph and above) in a closed lane or shoulder without portable or permanent traffic barriers separating the work area from the traveled lanes.

2. Any situation on a multi-lane highway (45 mph and above) where a TMA is depicted or labeled as required or optional on a shadow vehicle in the OMUTCD.

Furnish a TMA for each work area if two or more localized work areas occur within the same stationary work zone and are separated by more than 700 feet.

Attach the TMA to the shadow vehicle in accordance with manufacturer specifications and place in advance of the work area according to recommended spacing in Table 614.03-1. Distances are considered as guidelines. However, engineering judgement should be used to alter distances to take into account traffic conditions, vehicle mix, sight distance, and other site-specific conditions.

TABLE 614.03-1

For Shadow Vehicles Weighing 22,000 lb. or More		
Speed Limit (MPH)	Recommended Spacing [1]	
	Stationary Operation (Ft)	Moving Operation (Ft) [2]
Greater than 55	150	172
45-55	100	150
Less than 45	74	100
For Shadow Vehicles Weighing Less than 22,000 lb. but Greater Than 9,900 lb.		
Speed Limit (MPH)	Stationary Operation (Ft)	Moving Operation (Ft) [2]
Greater than 55	172	222
45-55	123	172
Less than 45	100	100

[1] Recommended spacing is distance between front of shadow vehicle and beginning of work area to provide adequate roll ahead distance and minimize the risk of vehicles cutting in ahead of the shadow vehicle.

[2] Distances are appropriate for speeds up to 15.5 mph.

614.035 Storage of Equipment, Vehicle and Material on Highway Rights of Way. Unless otherwise permitted by the Engineer, locate all equipment, vehicles, and material stored or parked on highway rights-of-way:

A. At least 6 feet behind the face of Existing Barrier and not within the 75 foot long by 20 foot wide Recovery Area behind the Existing Barrier run, or;

B. Not less than 30 feet from the nearest edge of the traveled way, or;

C. At least 6 feet behind raised curbs.

Additionally, at night, encompass any such equipment, vehicles or material with drums, equipped with Type A warning lights, spaced at 5 feet on center.

For locations with traffic approaching from more than one direction or side (e.g., medians, between mainline and ramps, etc.), ensure the requirements are met for all traffic approaches.

Existing Barrier, for purposes of 614.035 only, includes and is limited to: existing permanent guardrail, existing concrete barrier, temporary or new permanent guardrail installed in accordance with the plans, temporary portable barrier installed in accordance with the plans, or new permanent concrete barrier installed in accordance with the plans. Other types of barrier not listed, such as cable barrier, are excluded as a means of protecting drivers from stored equipment, vehicles and material on highway rights-of-way.

Recovery Area, for purposes of 614.035, shall have slopes 3:1 or flatter and be free of workers, hazards, equipment, vehicles, drop-offs, and material storage. The Recovery Area length is to begin at the terminus of the Existing Barrier run. Any gating impact attenuator length shall not be included as part of the Recovery Area length.

614.04 Work Zone Marking Signs. Furnish, install, maintain, and subsequently remove work zone marking signs and their supports within the work limits according to the following requirements:

A. Erect a NO EDGE LINES sign in advance of any section of roadway lacking OMUTCD standard edge line markings. Ensure these signs are in place before opening the roadway to traffic. Erect these signs on each entrance ramp, 25 to 200 feet beyond the far shoulder or curb line of intersecting through roads to warn entering or turning traffic of the conditions, and at least once every 2 miles (3 km) along the roadway. Remove these signs when they no longer apply.

B. Erect a DO NOT PASS sign at the beginning and a PASS WITH CARE sign at the end of each no passing zone lacking OMUTCD standard center line markings.

614.05 Road Closed. When the highway is closed to traffic, furnish, erect, maintain, and subsequently remove advanced warning signs and supports, barricades, ROAD CLOSED signs on the barricades, and Type B yellow flashing lights at the following locations:

A. Work limits of the project.

B. Work limits on all intersecting roads.

C. Any other points specified in the Contract.

Throughout construction, furnish, erect, maintain, and subsequently remove all signs, lights, barricades and other traffic control devices required by the OMUTCD, plans, or standard construction drawings for the maintenance of local traffic.

614.055 Surface Condition Signs. Erect a GROOVED PAVEMENT sign 250 feet (75 m) in advance of any section of roadway where traffic must travel on a planed surface. Ensure these signs are in place before opening the roadway to traffic. Erect these signs on each entrance ramp and at intersections of through roads to warn entering or turning traffic of the conditions. Payment for these signs to be included in Item 614 Maintaining Traffic.

614.06 Detour Signing.

A. Department Detour Signing. When the Contract Documents do not require the Contractor to furnish the signing for designated detour routes, the Department will furnish, erect, maintain, and subsequently remove the detour routing signs and supports required on the designated detour highways outside the Project.

B. Contractor Detour Signing. When the Contract Documents provide a pay item for Detour Signing and the plans provide a detour-signing plan, provide, maintain, and subsequently remove all required detour signing and supports according to the detour signing plan.

614.07 Traffic Maintained. Where the highway under construction is being used by through traffic, including periods of suspension of the work, furnish and maintain pavement markings, lights, construction signs, barricades, guardrail, sign supports, and such other traffic control devices. Maintain pre-existing roadside safety hardware at an equivalent or better level than existed prior to project implementation. Also, provide law enforcement officers, watchmen, and flaggers as

necessary to maintain safe traffic conditions within the work limits as directed by the Engineer.

The Department will furnish and erect regulatory signs and guide signs, unless otherwise shown on the plans, within the work limits on all traffic maintained projects. The Contractor is responsible for maintenance of these signs. The Engineer will approve the erection and removal of any regulatory signs not shown on the plans.

Keep existing signs including 630.09 Specific Service signs, Tourist-Oriented Directional Signs, and Sponsor-A-Highway signs and traffic control devices in use within the work limits during the construction period unless otherwise indicated on the plans. If existing signs and other traffic control devices must be relocated or modified as a consequence of the work, provide suitable supports and modify the devices with prior approval of the Engineer and the concurrence of the maintaining agency. Keep existing STOP or YIELD signs functioning at all times. The Contractor may adjust the position of these signs with the Engineer's approval. Relocate existing signs that must be adjusted laterally according to the OMUTCD. Restore relocated or modified signs to the position and condition that existed before construction as directed by the Engineer. When signs are to be covered, provide an opaque covering that covers the entire message, symbol and all of the sign within the border. Do not use fastenings that damage the sign or reflective face; however, the Contractor may use rivets to attach rigid overlay panels. Do not apply adhesive tapes directly to the face of the sign.

When an existing signal operation must be interrupted for a period of time, provide a traffic control method approved by the Engineer.

Whenever it is necessary to divert the flow of traffic from its normal channel into another channel, clearly mark the channel for such diverted traffic with cones, drums, barricades, vertical panels, pavement markings, or arrow boards. Also use this method of marking where working adjacent to the part of the highway in use by the public.

Obtain the approval of the Engineer before closing a traffic lane or establishing a one-way traffic operation.

614.08 Flaggers. Whenever one-way traffic is established, use at least two flaggers unless the Engineer authorizes otherwise, and erect signs, cones, barricades, and other traffic control devices according to the OMUTCD. Reflectorize traffic control devices as previously noted. Maintain positive and quick means of communication between the flaggers at the opposite ends of the restricted area.

Equip flaggers according to the standards for flagging traffic contained in the OMUTCD. During a flagging operation, other than an intersection or a spot location best controlled by a single flagger, ensure that each flagger uses a STOP/SLOW paddle conforming to the OMUTCD. Mount the paddle on top of a 6 1/2 foot (2 m) handle. Ensure that each face of the paddle is made of Type G reflective sheeting meeting the requirements of 730.19. While flagging, do not allow flaggers to perform other work activities. The Contractor may, instead of using flaggers, or supplemental to them, furnish, install, maintain and operate a traffic signal or

signals, for the purpose of regulating traffic according to a written agreement approved by the Engineer.

The Contractor may (supplemental to using flaggers) furnish, install, maintain and operate automated flagger assistance devices (AFADs) with incidental items, for the purpose of assisting the flagger(s) in regulating traffic according to a written agreement approved by the Engineer. AFADs shall be furnished per the Department's Approved List and shall be used in accordance with Supplemental Specification 830.

614.09 Law Enforcement Officer. When shown on the plans, furnish the services of a law enforcement officer and patrol car equipped with flashing lights.

614.10 Work Zone Traffic Signals. If shown on the plans, furnish, erect, maintain, and subsequently remove signal equipment conforming to Items 632 and 732, and signal controller equipment of a proper type and capacity to provide the required operation. Furnish and install Uninterruptible Power Supplies (UPS) conforming to 733.09. Subject to the Engineer's approval, the Contractor may use new equipment that is to be installed later on the project, or may install used equipment in good condition provided such used equipment meets current Department specifications. The performance test in 632.28 and the working drawing requirements of 632.04 are waived. Recondition used equipment as necessary to ensure proper operation. Operate work zone traffic signals conforming to the requirements of the OMUTCD and subject to the approval of the Engineer.

Procure and pay for electric power for work zone traffic signals. Do not alter the operation of an approved work zone traffic signal without the Engineer's approval. Correct any malfunctions or failures without delay. Cover or remove work zone traffic signals not in use. Covering of one or more permanent or temporary vehicle or pedestrian signal head(s) shall be according to 632.25, except payment shall be included in Item 614 Maintaining Traffic.

Energized signal covers shall block light from being visible.

614.11 Work Zone Pavement Markings. Furnish, install, maintain, and, when necessary, remove work zone retroreflective pavement markings on existing, reconstructed, resurfaced or temporary roads within the work limits, according to the following requirements.

A. Acceptability and Expected Duration. The Engineer will evaluate the markings according to the performance parameters contained in Supplement 1047, Appendices C, D and E. Repair or replace the markings when the numerical rating is six or lower for Daytime Color (Appendix C), or a composite rating of 6 or lower for Night Visibility (Appendix D), or five or lower for Durability (Appendix E). Repair or replace unsatisfactory markings immediately and at no additional cost to the Department, if the markings were in place for 120 calendar days or less. The Department will compensate under the applicable contract pay item for work zone pavement marking for the ordered replacement of worn markings after 120 calendar days under traffic.

B. Work Zone Marking Specifications. Equip traffic paint striping equipment for Class I and Class III markings with a computerized Data Logging System (DLS)

conforming to 641.04. Furnish the Engineer daily, biweekly, and final DLS reports according to 641.04.

Unless otherwise shown on the plans, the Contractor may use 740.02 Type 1 or Type 1A paint, Supplemental Specification 807 Traffic Paint, Supplemental Specification 873 Wet Reflective Removable Tape, 740.10, or 740.06 Type I or Type II preformed material for work zone pavement markings. Do not use wet reflective optics specified in Supplemental Specification 807 with 740.02 Type 1A paint for cold weather applications. Unless using Supplemental Specification 807 Traffic Paint, furnish painted markings according to Item 642 except that:

1. For Class I or Class II work zone pavement markings, use the specified application rate from Table 614.11-1.

TABLE 614.11-1

	Line Width (inch)				
	4	6	8	12	24
Type of Pavement Marking	**Gallon per Mile of Line**				
Solid Line	22	33	44	66	132
10-foot Dashed Line	5.5	8.25	--	--	--
4-foot Dashed Line	2.2	3.3	--	--	--
Dotted Line	7.3	10.95	14.6	21.9	--
Arrows, Symbols, and Words	1.4 gallons per 100 square feet				
Glass Beads: 740.09, Type A	15 pounds per 100 square feet				

TABLE 614.11-1M

	Line Width (mm)				
	100	150	200	300	600
Type of Pavement Marking	**Liter per Kilometer of Line**				
Solid Line	52	78	105	157	314
3.0 m Dashed Line	13	19.5	--	--	--
1.2 m Dashed Line	5.2	7.8	--	--	--
Dotted Line	17.3	25.95	34.6	51.9	--
Arrows, Symbols, and Words	0.6 liters per square meter				
Glass Beads: 740.09, Type A	7.3 kg per square meter				

2. For Class III work zone markings, use the specified application rate from Table 614.11-2.

TABLE 614.11-2

	Line Width (inch)				
	4	6	8	12	24
Type of Pavement Marking		**Gallon per Mile of Line**			
Solid Line	12	18	24	36	72
10-foot Dashed Line	3	4.5	--	--	--
Dotted Line	4	6	8	12	--
Arrows, Symbols, and Words	0.75 gallons per 100 square feet				
Glass Beads: 740.09, Type A	7.5 pounds per 100 square feet				

TABLE 614.11-2M

Type of Pavement Marking	Line Width (mm)				
	100	150	200	300	600
	Liter per Kilometer of Line				
Solid Line	28	42	56	84	168
3.0 m Dashed Line	7	10.5	--	--	--
Dotted Line	9.4	14.1	18.8	28.2	--
Arrows, Symbols, and Words	0.3 liters per square meter				
Glass Beads: 740.09, Type A	3.7 kg per square meter				

Ensure that Type I and II preformed material conform to 740.06 or wet reflective preformed material conforms to Supplemental Specification 873, except do not place any preformed material containing metal on any surface unless it will be removed later. Remove work zone pavement markings of 740.06 or Supplemental Specification 873 preformed material before placement of 642 or 644 surface course markings at that location. Ensure that preformed material conforms to Item 645 or Supplemental Specification 873.

C. Work Sequence. Ensure that work zone markings are complete and in place on all pavement, including ramps, before exposing the pavement to traffic. When work zone markings conflict with the traffic pattern, remove them according to 641.10.

D. Layout and Premarking. Layout and premark all Class I and Class III Markings according to 641.06. Obtain the Engineer's approval of the layout and premarking lines before marking operations are started.

E. Tolerances. Place lines for final surfaces according to the tolerances of 641.07. On surfaces other than final, the Department will allow tolerances twice that in 641.07.

F. Classes of Work Zone Pavement Markings.

1. Class I Markings (Full Pattern, Full Rate). Use Class I Markings on all surfaces exposed to traffic for more than 14 days prior to application of final markings and to over-winter the project, with the following exception: Do not use Class I Markings on a surface course if thermoplastic, spray thermoplastic or epoxy final markings are to be applied to the surface course. If thermoplastic, spray thermoplastic or epoxy final markings are to be applied to the surface course, use Class III Markings on that course. Apply Class I work zone markings to the standard dimensions as defined in Item 641, except as follows:

a. Edge Lines. Class I edge lines shall match existing edge line in width, 4 or 6 inches (100 or 150 mm).

b. Lane Lines. Class I lane lines shall match existing lane line in width, 4 or 6 inches (100 or 150 mm).

c. Channelizing Lines. Class I channelizing lines shall match existing channelizing line in width, 8 or 12 inches (200 or 300 mm).

2. Class II Markings (Abbreviated, Full Rate). Use Class II Markings for short-term use when traffic is to be maintained in parallel lanes nominally in the

same location as permanent lanes and where tapers or transitions are not required or other features will not likely divert traffic from the intended path. Class II Markings are limited to center lines, lane lines and gore markings defined as follows:

a. Center Lines. Class II center lines consist of single, yellow 4-inch (100 mm) wide by a minimum of 4 feet (1.2 m) long dashes spaced at a maximum of 40 feet (12.0 m) intervals. No Passing Zones must be marked with Class I or Class III Markings or final markings within 3 calendar days according to 614.11.H.1. Passing Zones must be marked with Class I or Class III Markings or final markings within 14 calendar days according to 614.11.H.2.

b. Lane Lines. Class II lane lines shall be white and shall match existing lane lines in width, 4 or 6 inches (100 or 150 mm), by a minimum of 4 feet (1.2 m) long dashes spaced at a maximum of 40 feet (12.0 m) intervals. Class II Lane Line Markings must be marked with Class I or Class III Markings or final markings within 14 calendar days according to 614.11. H. 3.

c. Gore Markings. Class II gore markings are continuous, white 24-inch (600 mm) wide lines in a chevron crosshatched pattern placed within the theoretical gore of an exit ramp or diverging roadways. Class II Gore Markings must be marked with Class I or Class III Markings or final markings within 14 calendar days according to 614.11.H.3.

Computerized Data Logging Systems (DLS) are not required for Class II Markings.

3. Class III Markings (Full Pattern, Low Rate). Use Class III Markings on surface courses that are expected to receive thermoplastic, spray thermoplastic or epoxy final markings within 30 days. Class III Markings use a lower application rate which reduces the surface preparation needed prior to application of thermoplastic, spray thermoplastic or epoxy final markings. If Class III Markings have been applied and weather conditions are expected to prevent thermoplastic, spray thermoplastic or epoxy final markings application for 30 days or more, re-apply Class III Markings (if thermoplastic, spray thermoplastic or epoxy final markings application is expected to occur within 30 days) or apply Class I Markings as necessary to carry the project through the season or over the winter.

Apply Class III work zone markings to the standard dimensions as defined in Item 641 except as follows:

a. Edge Lines. Class III edge lines shall match existing edge line in width, 4 or 6 inches (100 or 150 mm).

b. Lane Lines. Class III lane lines shall match existing lane line in width, 4 or 6 inches (100 or 150 mm).

c. Channelizing Lines. Class III channelizing lines shall match the existing channelizing line in width, 8 or 12 inches (200 or 300 mm).

G. Conflicting Markings. Conflicting markings are considered to be any markings not actively in use, not behind channelizing devices or portable barrier and/or could be misinterpreted by the traveling public or cause confusion to the

driver as determined by the engineer. Before placing work zone markings, remove or cover all conflicting existing markings visible to the traveling public.

1. Removal and Covering of Markings.

a. Removal Methods. Remove the markings so that less than 5% of the line remains visible. Repair damage to the pavement that results in the removal of more than 1/8 inch of pavement thickness.

Use sand, shot, or water blasting to remove markings on all asphalt or concrete pavement surfaces.

A grinder may only be used to remove markings on temporary pavement or pavement that will be covered or removed prior to project completion (e.g., intermediate asphalt course). When a grinder drum is mounted to a skid steer loader, the drum must be able to accommodate a minimum of 150 teeth.

b. Covering Conflicting Markings. With the Engineer's approval, use removable, non-reflective, preformed blackout tape to cover conflicting markings. Remove or replace the blackout tape within 15 days of installation. Furnish products according to the Departments Qualified Products List (QPL).

2. Raised Pavement Markers. Remove the prismatic retro-reflector within any raised pavement marker that is in conflict with the work zone pavement markings. When the work zone pavement markings are removed and the raised pavement marker is no longer in conflict, thoroughly clean the recessed reflector attachment area of the casting and install a new prismatic retro-reflector of the same kind and color. The cost for this work is incidental to the various pay items.

H. Allowable Duration of Work Zone Markings.

1. No Passing Zones. When existing permanent no-passing-zone markings are removed or obliterated as the result of a construction operation (pavement grinding, asphalt concrete pavement overlays, etc.) and the section of pavement continues to be used by the traveling public, place Class I Center Line Markings or final center line markings as specified by the plan within 3 Calendar Days unless thermoplastic, spray thermoplastic or epoxy final markings are to be applied on the surface course. If thermoplastic, spray thermoplastic or epoxy final markings are to be applied on the surface course, place Class III Center Line Markings or final center line markings as specified in the plan within 3 Calendar Days.

a. Subsequent Work in No Passing Zones. If, after the original markings are removed or obliterated, the Contractor returns to the subject no passing zone and places a plan-specified pavement course within the 3-Calendar Day limit, or performs work in preparation for a subsequent pavement course, the Contractor shall have temporarily satisfied the conditions of the previous paragraph. In this event, the 3-Calendar Day limit will begin again.

b. Liquidated Damages. For each Calendar Day beyond 3 days that this work remains incomplete, the Department will assess liquidated damages in the amount of $1000 per Calendar Day. The Department will treat the time for the completion of no-passing-zone markings as an interim Completion Date.

2. Passing Zones. Sections of pavement where passing is permitted in both directions must be marked with Class I Center Line Markings or final center line markings as specified by the plan within 14 Calendar Days unless thermoplastic, spray thermoplastic or epoxy final markings are to be applied on the surface course. If thermoplastic, spray thermoplastic or epoxy final markings are to be applied on the surface course, place Class III Center Line Markings or final center line markings as specified in the plan within 14 Calendar Days.

3. Allowable Duration of Class II Lane Lines and Gore Markings and Absence of Edge lines. Any time existing permanent lane lines, gore markings, or edge lines have been removed or obliterated as the result of a construction operation (pavement grinding, asphalt pavement overlays, pavement widening, etc.) and the section of pavement continues to be used by the traveling public, place Class I Markings or final markings as specified by the plan within 14 Calendar Days unless thermoplastic, spray thermoplastic or epoxy final markings are to be applied on the surface course. If thermoplastic, spray thermoplastic or epoxy final markings are to be applied on the surface course, place Class III Markings or final markings as specified in the plan within 14 Calendar Days.

a. Subsequent Work. If, after the original markings are removed or obliterated, the Contractor returns to the subject section of pavement and places a plan-specified pavement course within the 14-Calendar Day limit, or performs specified work that requires a lane closure (except routine maintenance required by 614.02), the Contractor shall have temporarily satisfied the conditions of the previous paragraph. In this event, the 14-Calendar Day limit will begin again.

b. Liquidated Damages. For each Calendar Day beyond 14 days that this work remains incomplete, the Department will assess liquidated damages in the amount of $1000 per Calendar Day. The Department will treat time for the completion of these markings as an interim Completion Date.

(1) Continuous Project. If a section of pavement is in a continuous part of the project, then a new 14-day limit for renewed work on a section applies to all sections in that part.

(2) Project in Sections. If the project is in parts and the traveling public could not discern the parts as one continuous project, then a new 14-day limit in one part will not apply to the other parts.

(3) Freeways and Divided Highways. Treat the two directional sides of a freeway as separate parts. Work on one side of a freeway does not create a new 14-day limit for the other side.

I. Removal of Work Zone Markings. Remove work zone retroreflective pavement markings when necessary. Accomplish removal of work zone pavement marking by using removal methods specified in 614.11G.1.a for removal of existing markings.

614.115 Work Zone Raised Pavement Markers. Furnish, install, maintain and subsequently remove work zone raised pavement markers (WZRPMs). Work zone raised pavement markers may serve as a substitute for, or supplement to, work zone

pavement markings. They are provided in both yellow and white versions to match the appropriate pavement marking color.

White units provide reflectorization in one direction while yellow units may provide reflectorization in either one direction or two. They are available as units which are readily visible both night and day as a result of retroreflectors and brightly colored (white or yellow) housing (Type A) or visible only at night due to their retroreflectors (Type B).

A. Materials. Furnish materials according to the Department's Approved List.

Only use adhesives that are recommended by the reflector manufacturer and are not epoxy.

Provide markers of sufficient strength and properly shaped so as not to be dislodged or broken by impacts from vehicle tires, including those of high pressure truck tires loaded to 4500 pounds (2040 kilograms).

Provide reflectors having an area of 0.35 square inches (225 square millimeters) for Type A or 3.0 square inches (1935 square millimeters) for Type B with brightness or specific intensity (when tested at 0.2 degree angle of observation and the following angles of incidence) meet or exceed the following:

WZRPM SPECIFIC INTENSITY

Type	Incidence Angle	White	Yellow
A	0	1.0	0.6
A	20	0.4	0.24
B	0	3.0	1.8
B	20	1.2	0.72
B	45	0.3	0.2

Angle of incidence: Formed by a ray from a light source to the marker and the normal to the leading edge of the marker face (also horizontal entrance angle)

Angle of observation: Formed by a ray from a light source to the marker and the returned ray from the marker to the measuring receptor

Specific intensity: The mean candlepower of the reflected light (at given incidence and divergence angles) for each footcandle (10.7 lux) at the reflector (on a plane perpendicular to the incident light)

Type A markers, when viewed from above, have a visible area of not less than 14 square inches (9030 square millimeters). When viewed from the front, parallel to the pavement, as from approaching traffic, Type A markers have a width of approximately 4 inches (100 mm) and a visible area of not less than 1.5 square inches (970 square millimeters).

B. Patterns. The patterns of WZRPMs required for the various types of pavement markings are shown in Table 614.115-1.

TABLE 614.115-1

SUPPLEMENTAL DELINEATION (TYPE A OR B)

Type of Line	Color	Spacing
Edge Line	1-way white or yellow	20' (6.0 m) c/c
Lane Line	1-way white	40' (12.0 m) c/c or at center of gap
Dashed Center Line	2-way yellow	40' (12.0 m) c/c or at center of gap
Double Center Line	2-way yellow	2 units; 20' (6.1 m) c/c
Channelizing Line	1-way white	10' (3.0 m) or 20' (6.0 m) c/c
Exit Gore (Outline)	1-way white	10' (3.0 m) c/c

SIMULATED DELINEATION (TYPE A ONLY)

Type of Line	Color	Spacing
Edge Line	1-way white or yellow	10' (3.0 m) c/c
Edge Line on 1-Lane, 2-Way	1-way white and 1-way yellow	white & yellow units back-to-back[2] 10' (3.0 m)
Lane Line	1-way white	3 units at 5'(1.5 m) c/c 30'(9.0 m) gap
Dashed Center Line	2-way yellow	3 units at 5'(1.5 m) c/c 30'(9.0 m) gap
Double Center Line	2-way yellow	2 units[1]; 10' (3.0 m)c/c
Channelizing Line	1-way white	5' (1.5 m) c/c
Exit Gore (Outline)	1-way white	5' (1.5 m) c/c

[1] Place units side by side about 4 inches (100 mm) apart.

[2] Face the proper color and reflector to the oncoming traffic. Place the units back to back about one quarter inch (6.0 mm) apart.

C. Installation. Attach work zone raised pavement markers to clean, dry and sound pavement. Remove all loose gravel, sand and dirt from the area of the line. The minimum pavement temperature for installation is 50 °F (10 °C). When markers are being attached to new concrete pavement with curing compound remaining, remove the curing compound membrane by sandblasting or other mechanical cleaning method. Install markers in accordance with the manufacturer's recommendations.

Work zone raised pavement markers are not suitable for use from October 15 to April 1. If the Contractor elects to start or continue work zone pavement markers during this period, and they fail or are subsequently removed or destroyed by snow and ice control activities, immediately, at his expense, provide a substitute traffic guidance system which is effective during day and night and which is acceptable to the Engineer. Other than for replacement of failed WZRPMs, new installations of WZRPMs are not permitted from October 1 to April 1.

Place markers accurately to depict straight or uniformly curving lines. The longitudinal location of WZRPMs are described in Table 614.115-1 except that the spacing of an individual WZRPM may be varied by as much as 2 feet (0.6 m) or 10

percent of the nominal spacing in order to avoid poor pavement conditions, but the average spacing remains unchanged. Poor pavement conditions include separated joints, cracks, deteriorated pavement, usually uneven pavement or where pavement marking material will interfere with the bond.

The lateral location of WZRPMs follows:

1. Edge Lines: Install the WZRPM 12 inches (300 mm) outside the work zone pavement marking, if any, or the theoretical edge of the lane. This offset may vary +6 inches (150 mm) as necessary to avoid poor pavement conditions.

2. Lane lines and dashed center lines: Install the WZRPM in the center of the gap between pavement marking dashes, if any. If a pavement joint exists, locate the marker approximately 2 inches (50 mm) clear from the joint (and to the left of it for lane lines). Otherwise, center the WZRPM on the theoretical edge of the lane.

3. Double center line: Install each WZRPM of the pair in line with the appropriate pavement marking stripe, if any. If the edge of lane is demarcated by a crack or joint, the pair of WZRPMs straddle the joint and install each approximately 2 inches (50 mm) clear from the joint. Otherwise center the pair on the theoretical edge of lane.

4. Channelizing Line: Install the WZRPM in line with the pavement marking stripe or immediately adjacent to the line, except when used at exit gore outlines where the WZRPM is installed within the painted gore vee and approximately 12 inches (300 mm) from the pavement marking stripe. Do not install WZRPMs directly on a painted line.

D. Replacement. Maintain WZRPMs in good condition. A marker will be considered to have failed when the marker is broken, the marker is worn to the extent that daytime visibility is significantly diminished or of an unacceptable color (type B only), the reflector is broken or detached, the marker is detached from the adhesive, the adhesive is detached from the pavement or the marker or reflector is covered by tar or paint.

Individual replacement of each failed marker as it occurs is not recommended due to increased exposure of workers to traffic. However, maintain the following minimum levels of marker effectiveness:

1. For a given line, no more than 20 percent of the WZRPM units failed in any manner;

2. For a segment of any line, the number of failed units does not exceed the maximums permitted in Table 614.115-2.

TABLE 614.115-2

Line Type	Normal Spacing Feet (Meter)	Segment Length Feet (Meter)	Normal No. Contained In Segment	Maximum No. Permitted To Fail
Edge	10 (3.0) 20 (6.0)	5 (1.5) 100 (30.0)	6	3
Center, Double/Solid	20 (6.0) 10 (3.0)	100 (30.0) 50 (15.0)	12	6
Lane or Dashed Center	40 (12.0) 5 (1.5)	200 (60.0) 1-Stripe	6	3
Channelizing	20 (6.0) 10 (3.0) 5 (1.5)	100 (30.0) 50 (15.0) 25 (7.5)	6	3

Replace all failed units within any line or segment before conditions deteriorate below the minimums established in Table 614.115-2. Replace all failed units within the line or segment within 24 hours after notification by the Engineer.

E. Removal. Accomplish removal of work zone raised pavement markers in such a manner that no adhesive remains on the pavement. Do not cause permanent pavement surfaces to be scarred, broken or significantly roughened.

614.12 Pavement Marking Operations. Perform moving marking operations with a truck equipped with necessary flashers and signs, and protect the operations with a similarly equipped vehicle or vehicles separated a sufficient distance to provide adequate advance warning. Use the extreme left or right lane for the marking operation when possible. Where three or more lanes exist in one direction, perform the marking operation so that traffic passes on one side only.

Protect stationary marking operations in intersections, school zones, gores and other areas with traffic control devices such as advance warning signs and cones.

For stationary operations such as loading material and cleaning equipment, make every effort to have all equipment completely off the traveled way. When equipment cannot be removed from the traveled way, operate all traffic control devices on the vehicles and station flaggers and vehicles to protect the worksite and the traveling public while maintaining traffic.

614.13 Asphalt Concrete for Maintaining Traffic. The Contractor may use either a Type 1 or Type 2 mix of Item 441 asphalt concrete PG 64-22, or an asphalt concrete surface course the Engineer approves.

Where materials are placed in small quantities or under adverse conditions, the Engineer may waive specification requirements for placing and finishing if, in the judgment of the Engineer, it is determined that the Contractor can obtain satisfactory results in providing a smooth and durable pavement surface.

This material is intended to be used to maintain pavement free from defects as described in 614.02.B.

614.14 Performance. If, in the opinion of the Engineer, the Contractor is not furnishing proper maintenance of traffic facilities and proper provisions for traffic control, the Department may take the necessary steps to place them in proper

condition, and the Department will deduct the cost of such services from any money that may be due or become due the Contractor.

Identify all pavement deficiencies within the work area. Repair deficiencies as soon as possible and within 24 hours from notice of the deficiency.

614.15 Method of Measurement. The Department will measure Work Zone Marking Signs as the number of sign installations, including the sign, necessary supports, and all attachment hardware. The Department will include all other work zone signs under Maintaining Traffic unless separately itemized.

The Department will measure Work Zone Pavement Markings complete in place, by class and material, in the units designated. Line quantities will be the length of the completed stripe, including gaps, intersections and other sections of pavement not normally marked. Work Zone Pavement Markings will include the layout, application and removal of the markings, when required.

The Department will measure line quantities as the length of the completed stripe, including gaps, intersections, and other sections of pavement not normally marked.

The Department will measure Sign Months for Portable Changeable Message Signs by the number of months each sign is at the project or project storage yard and immediately available to the project for use. Measurement will begin when each unit is in active service and will continue until the Engineer determines the Portable Changeable Message Sign is no longer needed for the remaining duration of the project. A Sign Month will be deducted if a PCMS is not working properly for more than 24 hours in one sign month or if the Contractor removes the PCMS from the project/project storage yard without the Engineer's determination that it is no longer needed for the project.

614.16 Basis of Payment. The Department will make partial payments according to 109.09 and as modified by the following schedule:

A. If the project duration from first day of physical work to original completion date is greater than or equal to 45 calendar days,

1. The Department will pay 30 percent of the lump sum amount bid for Maintaining Traffic with the first estimate, but not sooner than 15 days after the start of work at the project site.

2. The Department will pay the remaining 70 percent of the lump sum amount bid for Maintaining Traffic according to 109.09.

B. Unless separately itemized, the lump sum price bid for Maintaining Traffic shall include the cost of removal or covering of conflicting pavement markings, layout, application and removal of pavement markings when required, maintaining the existing highway in a safe condition for public use, removing abrasive and salt residue remaining from snow and ice control performed by the Department or local governments, providing flaggers and their equipment, and furnishing, maintaining in an acceptable condition, and subsequently removing the following work zone traffic control items as required by the Contract Documents:

1. Signs, supports, and warning lights.

2. Drums, cones, gates, barricades, and vertical panels.

3. Arrow boards.
4. Work zone traffic signals.
5. Lighting for work zone signals and flaggers.
6. TMAs.

C. If traffic permanently damages beyond use any of the work zone traffic control items listed in 107.15, the Department will compensate the Contractor for replacement of the damaged item by Change Order provided the Contractor has pursued but failed to obtain compensation from the motorist

The lump sum price bid for Detour Signing includes the cost of the Contractor furnishing, installing, maintaining, and removing the detour signing shown on the plans and their necessary supports.

C&MS Table 104.02-2 does not apply to final quantities of Law Enforcement Officer with Patrol Car.

The Department will pay for the following items under their associated item numbers: 502 Bridges, 615 Roads and Pavement, 622 Concrete Barrier. The Department will pay for aggregate and calcium chloride authorized by the Engineer and used for Maintaining Traffic under Items 410 and 616.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
614	Lump Sum	Maintaining Traffic
614	Lump Sum	Detour Signing
614	Each	Replacement Drum
614	Each	Replacement Sign
614	Each	Object Marker, ___ - Way
614	Each, Mile, Foot (Kilometer, Meter)	Work Zone Pavement Markings
614	Each	Work Zone Raised Pavement Marker
614	Sign Month	Portable Changeable Message Sign
614	Each	Work Zone Speed Limit Sign
614	Each	Work Zone Marking Sign
614	Hour	Law Enforcement Officer with Patrol Car
614	Each	Barrier Reflector
614	Each	Work Zone Crossover Lighting System
614	Each	Work Zone Impact Attenuator, ____*** Wide Hazards, ____****
614	Mile (Kilometer)	Work Zone Lane Line, Class ___, ___*, ___**
614	Mile (Kilometer)	Work Zone Center Line, Class ___, ___**
614	Foot (Meter)	Work Zone Channelizing Line, Class ____, ___*, ___**
614	Mile (Kilometer)	Work Zone Edgeline, Class ____, ___*, ___**
614	Foot (Meter)	Work Zone Gore Marking, Class II, ___**
614	Foot (Meter)	Work Zone Stop Line, Class I, ___**
614	Foot (Meter)	Work Zone Arrow, Class I, ___**
614	Foot (Meter)	Work Zone Crosswalk Line, Class I, ___**
614	Foot (Meter)	Work Zone Dotted Line,

		Class ___, ___ *, ___ **
614	Cubic Yard (Cubic Meter)	Asphalt Concrete for Maintaining Traffic

* Width of marking (4" or 6" for Lane Lines, Edgelines and Dotted Lines; 8" or 12" for Channelizing Lines and Dotted Lines).

** Type material (807 paint; 642 paint; 740.06, Type I or Type II; 873; 648; or left blank to allow any of the six.)

*** Width (24 in or over 24 in and less than 36 in).

**** Configuration (Unidirectional or Bidirectional).

ITEM 615 ROADS AND PAVEMENTS FOR MAINTAINING TRAFFIC

615.01 Description. This work consists of providing, maintaining, and subsequently removing roads and appurtenances, and pavements for maintaining traffic.

615.02 Fences. If necessary, replace permanent fencing with temporary fencing while occupying any temporary Right-of-Way, provide, erect, and maintain comparable temporary fencing during the period of construction. Take ownership of the existing fence. The Contractor may use this material in the erection of the temporary fence.

Before occupancy of the temporary Right-of-Way is terminated and before removal of the temporary fence, the Engineer will notify the property owner to reinstall permanent fencing according to the Right-of-Way settlement.

615.03 Earthwork. Excavate and construct embankment necessary for providing and maintaining temporary roads and any associated drainage facilities, as well as subsequent removal of temporary roads and restoration of the areas to their original condition, according to Item 203. Construct adequate side ditches in cut sections, and provide drainage pipe and culverts where necessary. Ensure the side slopes are not steeper than 1.5:1, unless otherwise shown on the plans.

615.04 Guardrail. Where the height of the embankment is 5 feet (1.5 m) or more, measured at the outside edge of the paved surface, and the side slope is steeper than 4:1, provide guardrail at a distance of at least 1.5 feet (0.5 m) from the edge of the required width of the surface course. Conform to one of the types of guardrail specified in Item 606, except that the Department will allow the Contractor to re-use material in good condition.

615.05 Pavement. Ensure that the pavement surface is constructed to the width shown in the plans, of the materials, and in the manner specified.

Prepare the subgrade in accordance with 204.03 and 204.04

Provide subgrade conforming to Item 204.03. Soft subgrade will be determined and replaced according to Item 204.04.

Provide aggregate shoulders, when specified, conforming to Item 411 for a minimum thickness of 6 inches.

Where Class A or Class B pavement is shown on the plans, provide either rigid pavement or flexible pavement conforming to the following minimum requirements:

MINIMUM COURSE THICKNESS REQUIRED

Pavement Type	Course Make-Up	Class A	Class B
Rigid	452	9 in (230 mm)	7 in (180 mm)
Flexible [6]	441 Type 1 [1]	1-1/4 in (32 mm)	1-1/4 in (32 mm)
	441 Type 2 [2] [5]	1-3/4 in (45 mm)	1-1/2 in (38 mm)
	302 [3] [5]	5-1/2 in (140 mm)	3-1/2 in (90 mm)
	304 [4] [5]	6 in (100 mm)	6 in (100 mm)

[1] Meet surface course requirements.
[2] Meet intermediate course requirements.
[3] The Contractor may use 301 or 441 Type 2 intermediate course.
[4] The Contractor may use 2-1/2 inches (65 mm) 301, 302, or 441 Type 2 intermediate course in lieu of 6 inches (150 mm) of 304.
[5] The Engineer may waive maximum placement lift thicknesses if quality control testing conforming to Supplement 1055 is performed and a final density between 93 and 96.5 percent is achieved.
[6] The Contractor may use 442 in lieu of 441.

For the indicated pavement type and courses, conform to the requirements of the specified items except as modified below.

For rigid pavements, conform to Item 452. Tiebars or hook bolts for longitudinal joints are not required. Use dowels only at transverse expansion and construction joints. Conform to the quality requirements set forth in 499.02 for the materials, except the requirements of 703.13. Use Class QC-1 concrete. For any part of the 452 pavement that is to be incorporated into the permanent pavement, the above exclusions do not apply and conformance to Items 452 and 499 is required.

For a 441 course, if the Contractor spreads and finishes the materials by acceptable hand methods, the Department will waive the requirements for smoothness.

Use a PG 64-22 asphalt binder for temporary asphalt pavement. If any part of the temporary pavement will be incorporated into the project permanently, then use the contract-specified PG asphalt binder grade for the pavement course.

For a 304 course, if the Contractor spreads the aggregate by approved hand methods, the Department will not require side forms. If the 304 course is to be removed, the Contractor may use reclaimed asphalt concrete or Portland cement concrete pavement.

Determine the thickness of the courses by field measurement.

615.06 Sidewalk. If temporary walks are required, provide the type of walk shown in the plans in accordance with Item 608.

615.07 Maintenance. Maintain all portions of the temporary facilities in good condition with respect to both safety and smoothness for travel as long as it is needed for maintenance of traffic. If the Engineer determines that the Contractor is not properly maintaining the temporary facilities, the Department may put them into proper condition according to 105.15.

615.08 Removal. If the temporary facilities are no longer needed, remove them, except such portions of the embankment as are shown on the plans to be a part of the new roadway embankment, and leave the area in a neat condition.

Take ownership of all material removed, unless otherwise shown on the plans. Use all suitable material in the work or legally use, recycle, or dispose in accordance with 105.16 and 105.17.

615.09 Method of Measurement. The Department will measure the quantity of Pavement by the number of square yards (square meters) of pavement surface (including paved and aggregate shoulders) placed, maintained, and removed as directed, measured complete in place.

The Department will measure areas of soft subgrade, undercut and replaced, according to 204.08.

615.10 Basis of Payment. Payment for Roads for Maintaining Traffic includes the installation, maintenance, and removal of all fencing, earthwork, guardrail, sidewalk, and all other items as necessary to provide a complete, functional, and safe installation for public use.

The Department will pay for areas requiring undercut and replacement conforming to 204.04 according to 204.09.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
615	Square Yard (Square Meter)	Pavement for Maintaining Traffic, Class A
615	Square Yard (Square Meter)	Pavement for Maintaining Traffic, Class B
615	Lump Sum	Roads for Maintaining Traffic

ITEM 616 DUST CONTROL

616.01 Description
616.02 Construction Requirements
616.03 Method of Measurement
616.04 Basis of Payment

616.01 Description. This work consists of applying water or dust palliative for the alleviation or prevention of dust nuisance originating from earthwork construction operations from within the project construction limits.

616.02 Construction Requirements. Perform dust control operations at the time and location and in the amount ordered by the Engineer. Maintain control of the application of water or dust palliative at all times to minimize dust but not to create saturated soil conditions. The Engineer will determine whether water or dust palliative is to be used to alleviate or prevent dust nuisance, and the amounts of each material to be used. Do not apply calcium chloride to areas that will be subsequently seeded or sodded.

Furnish and apply water used for dust control by means of tanks equipped with suitable sprinkling devices.

Use dust palliative consisting of 712.02 calcium chloride or a brine solution containing a minimum of 30 percent by weight of calcium chloride. Spread the calcium chloride uniformly over the surface.

616.03 Method of Measurement. The Department will measure Water by the number of M gallons (1000 gallon units) (cubic meters) applied and measured either in tanks, tank wagons, or trucks of predetermined capacity; or by means of meters of a type and furnished and installed by the Contractor at no expense to the Department; or determined by weight conversion.

The Department will measure Calcium Chloride by the number of tons (metric tons) by weight measurement, furnished and applied. When brine is used, the Department will determine the weight of calcium chloride by multiplying the number of gallons (cubic meters) by the factor 0.0024 (0.575).

616.04 Basis of Payment. The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
616	M Gallons (Cubic Meter)	Water
616	Ton (Metric Ton)	Calcium Chloride

ITEM 617 RECONDITIONING SHOULDERS

617.01 Description. This work consists of preparing the shoulder, and furnishing and compacting additional aggregate on the existing or prepared shoulder.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

617.02 Materials. Furnish materials conforming to 703.18.

617.03 Prosecution. If reconditioning shoulders as part of a resurfacing project and traffic is maintained, place shoulder material along with the paving operations as rapidly as possible. Complete all shoulder reconditioning within four days following placement of the surface course and any course that results in a drop-off of 2.0 inches or greater. Adjacent to a safety edge constructed as part of the Work, complete all shoulder reconditioning within ten days following construction of the safety edge.

617.04 Shoulder Preparation. If shoulder preparation is specified, loosen the existing surface to a depth of 1 to 2 inches. If the surface is an asphalt mix or seal, cut the surface along the edge of the pavement with a blade or disc to give a straight vertical edge. Do not cut a safety edge installed as part of the Work. Reduce pieces of loosened material that exceed approximately 1 1/2 inches in size to at least this maximum size or consider these pieces unsuitable material. Remove and dispose of oversized or other unsuitable material that would interfere with placing of aggregate. Reshape the loosened material as necessary to conform to the requirements for placing aggregate.

617.05 Furnishing and Compacting Additional Aggregate. Spread aggregate with approved spreaders. Do not dump or store aggregate on the pavement. Remove spilled aggregate from the pavement as spreading progresses.

Where the shoulder is relatively level, compact the material using crawler-type tractors, tamping rollers, trench rollers, suitable pneumatic tire rollers, or other suitable equipment. Use a minimum of four passes with compaction equipment weighing at least 6 tons. Perform the final compaction of the surface of the shoulder using a pneumatic tire roller. Where it would be unsafe to use the above compaction equipment due to the grade or width of the shoulder, use a side-mounted roller or side-mounted vibrating plate compactor that is securely attached to a tractor or other construction equipment. The side-mounted roller or side-mounted vibrating plate compactor must be able to adequately compact the aggregate while the equipment to which it is mounted remains on the paved surface. Use a minimum of four passes with the side-mounted roller and two passes with the side-mounted vibrating plate compactor. Compact the aggregate immediately after the spreading operation to prevent the loss of contained moisture and displacement of the material.

Apply water as directed by the Engineer when required to aid compaction and to prevent segregation of the material.

617.06 Method of Measurement. The Department will measure Shoulder Preparation by the number of square yards.

The Department will measure Compacted Aggregate, by the number of cubic yards in place computed from the profile grade and typical sections.

The Department will measure Water by the number of M gallons or 1000 gallon units according to 616.03.

If the plans provide for the use of aggregate in a variable width or depth course and the Department cannot readily calculate the quantity from profile grade and typical sections, the Department will measure the cubic yards by converting from weight using the following conversion factors:

TABLE 617.06-1

Material	Conversion Factor
Crushed stone	3800 lb/yd^3
Crushed gravel	3900 lb/yd^3
Crushed slag [1]	
less than 90 lb/ft^3	3600 lb/yd^3
90 to 100 lb/ft^3	4000 lb/yd^3
more than 100 lb/ft^3	4500 lb/yd^3
Recycled Portland Cement Concrete	3400 lb/yd^3
Reclaimed Asphalt Pavement	4000 lb/yd^3

[1] Based on average dry rodded weight of standard sizes of slag aggregates on record at the Laboratory. The conversion factors listed are the long gradation weights. These numbers are based on the dry rodded weights of No. 67, 57, or 8 gradation. The Department will determine slag weights based on weights obtained from the original source.

The Department will classify salvaged or mixed materials according to the material that makes up the majority of the mixture.

The moistures of the delivered material will be less than 2 percent above saturated surface dry condition or the payment will be based on the dry densities and dry weights.

Furnish freight bills or certified weigh bills according to Item 109.

617.07 Basis of Payment. The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
617	Square Yard	Shoulder Preparation
617	Cubic Yard	Compacted Aggregate
617	M Gallons	Water

ITEM 618 RUMBLE STRIPS

618.01 Description. This work consists of grinding depressions longitudinally in paved shoulders (rumble strips), at locations shared by edge lines or center lines

(rumble stripes), or cutting grooves transversely across lanes (transverse rumble strips).

Construct longitudinal rumble strips according to the standard construction drawings BP-9.1 (Shoulder Rumble Strips) or TC-64.10 (Rumble Stripes), and transverse rumble strips according to standard construction drawing BP-9.2 (Transverse Rumble Strips).

618.02 Construction.

A. General. Equip the cutting tool with guides or a guidance system, clearly visible to the operator, to provide for consistent alignment. Take effective measures to control dust during the grinding operation. Remove and dispose of all grinding materials deposited on the roadway pavement in a manner approved by the Engineer and before opening the roadway to traffic.

B. Longitudinal Rumble Strips. Furnish equipment with a rotary cutting head that will grind the depressions to the required dimensions. Equip the cutting head with a pattern of cutting tips to produce a smooth cut with approximately 0.06 inches (1.5 mm) between peaks and valleys. Ensure that the cutting head is on its own suspension system, independent from that of the power unit, to allow the head to align itself with the slope of the shoulder or any irregularities in the shoulder surface.

C. Transverse Rumble Strips. Use equipment to install Transverse Rumble Strips to the requirements of the plans and specifications without damaging surrounding pavement, pavement markings, or other project features.

618.03 Method of Measurement. The Department will measure longitudinal rumble strips by the number of feet (meters) or mile (kilometer) as the sum of the lengths of the individual segments. The Department will measure lengths along the inside edge of the shoulder, edge line or center line, from the center of the first depression in a segment to the center of the last depression in that segment. If longitudinal rumble strips are provided on more than location, the Department will measure lengths separately for each shoulder, center line or edge line segment and add the individual lengths together to obtain the total length for the shoulder, center line or edge line.

The Department will measure transverse rumble strips by the number of each for one pad consisting of fifteen parallel 4-inch grooves cut at 1-foot intervals.

618.04 Basis of Payment. The Department will not pay for repairing surface damage and extraneous marks caused by the Contractor's operations.

The Department will pay for longitudinal pavement marking material in accordance with Item 641.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
618	Feet (Meter)	Rumble Strips, Shoulder (Asphalt Concrete)
618	Mile (Kilometer)	Rumble Strips, Shoulder (Asphalt Concrete)
618	Feet (Meter)	Rumble Strips, Shoulder (Concrete)
618	Mile (Kilometer)	Rumble Strips, Shoulder (Concrete)
618	Feet (Meter)	Rumble Stripes, Edge line (Asphalt Concrete)

618	Mile (Kilometer)	Rumble Stripes, Edge line (Asphalt Concrete)
618	Feet (Meter)	Rumble Stripes, Edge line (Concrete)
618	Mile (Kilometer)	Rumble Stripes, Edge line (Concrete)
618	Feet (Meter)	Rumble Stripes, Center line (Asphalt Concrete)
618	Mile (Kilometer)	Rumble Stripes, Center line (Asphalt Concrete)
618	Feet (Meter)	Rumble Stripes, Center line (Concrete)
618	Mile (Kilometer)	Rumble Stripes, Center line (Concrete)
618	Each	Rumble Strips, Transverse (Asphalt Concrete)
618	Each	Rumble Strips, Transverse (Concrete)

ITEM 619 FIELD OFFICE

619.01 Description. This work consists of providing, maintaining, cleaning and subsequently removing a field office for the exclusive use of the Department for the duration of the Contract at a location approved by the Engineer.

619.02 General. Furnish a completely functional field office of the type specified in the Contract by the date directed by the Engineer.

Furnish each field office with a means for maintaining a room temperature between 68 and 80 °F (20 and 27 °C).

Furnish electric service for each field office.

Furnish potable hot and cold water for each field office.

Furnish neat, sanitary, enclosed toilet accommodations for each field office. Furnish associated lavatory and sanitary supplies. Portable facilities may be provided with the approval of the Engineer.

For projects requiring moisture and density control of construction materials, provide the field office with a lockable wood or metal storage box of sufficient size to store a nuclear density gauge and with a working electrical connection to charge the gauge. Provide two independent lock systems: one that locks the box the gauge is stored in; and the second one that locks the box to the facility within which the box is housed. The second lock system may consist of bolting the box to the office floor or wall. The storage box must be at least 15 feet (5 meters) from any occupied work area.

For the type of field office specified, provide the items indicated in Table 619.02-1

TABLE 619.02-1 FIELD OFFICE

Item	Type A	Type B	Type C
Minimum ceiling height, ft (m)	7 (2.1)	7 (2.1)	7 (2.1)
Floor space, ft² (m²)	150 (14)	500 (46)	1000 (93)
Separate enclosed room, ft² (m²) (Part of specified floor space)	0 (0)	0 (0)	100 (9)
Telephone service [1]	2	2	2
Internet service connection [5]	1	1	1
Multi-Function copier that is setup for scanning, printing and copying. [2]	1, 11×17	1, 11×17	1, 11×17
Calculator with tape	1	2	3
Desk and chair set	1	3	5
Work table, 30 × 72-inch (750 × 1800 mm)	1	2	3
4-drawer, legal size, lockable metal file cabinet	---	1	2
2-drawer, metal file cabinet	1	2	2
Portable fire extinguishers [3]	1	1	2
Plan rack [4]	1	1	2
All-weather parking spaces	8	16	20

[1] For each telephone and/or computer station specified, all ethernet wiring necessary to connect the phone and/or computer and multi-function copier to the internet company system.

[2] Copier must meet minimum specifications provided for each field office type. Contractor responsible for paper supplies, copier supplies, and maintenance of copier.
Type A:
One of the following MFC machines/series:
HP models E77822dn, E77825dn, E77830dn, E87640dn, E87650dn, E87660dn, E77822z, E77825z, E77830z, E87640z, E87650z, E87660z
Type B and C:
One of the following MFC machines/series:
HP Models: E77650dn, E77660dn, E77650dns, E77660dns, E77650z, E77660z, E77650zs, E77660zs, E77660zts, E77650z+, E77660z+, E77822dn, E77825dn, E77830dn, E87640dn, E87650dn, E87660dn, E77822z, E77825z, E77830z, E87640z, E87650z, E87660z

[3] Type 2-A:10-B:C, 5-pound (2.27 g) size

[4] Capable of handling the breakdown of 22 □ 34-inch (559 □ 864 mm) sized plans into ten sections.

[5] Provide a broadband internet connection capable of minimum download speeds as follows:
30 Mbps download 5 Mbps upload - Network Latency less than 50 milliseconds. If speeds are not available through an individual or singular circuit, provide the highest speed available in the area and install multiple circuits to achieve the specified speeds. When multiple broadband services are available the following is the preferred order: Cable, DSL, Cellular, and Wireless Radio (Satellite Communication is not compatible with ODOT VPN connection and will not be accepted). If a cellular network is used, provide the cellular equipment, including software and router equipment to connect to the ODOT provided Cisco ASA 5505 firewall. Supply ODOT with all documentation for the broadband circuit including all username/user ids, passwords and account information. Verify that the broadband internet connection is active and working as specified. ODOT IT personnel will confirm that bandwidth and network latency are compliant with the required field office specifications. All field office Internet connections are for ODOT use only.

With the Engineer's written approval, the Contractor may modify the requirements for the field office.

Maintain all utility services (e.g., electric, security, telephone, water) for the duration of the project.

619.03 Method of Measurement. The Department will measure Field Office, Type ___ by the number of months the office is maintained. A partial month at the end of the project will be paid as a full month.

619.04 Basis of Payment. The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
619	Month	Field Office, Type ___

ITEM 620 DELINEATORS

620.01 Description
620.02 Materials
620.03 Layout
620.04 Removal
620.05 Installation
620.06 Method of Measurement
620.07 Basis of Payment

620.01 Description. This work consists of furnishing and installing delineators, removing existing delineators for disposal, and restoring the surface where delineators are removed.

620.02 Materials. Furnish materials conforming to:

Reflectors 720.01
Posts, flexible 720.03
Steel hardware 730.08
Brackets 730.09
Stainless steel hardware..... 730.10
Aluminum hardware 730.17
Reflective sheeting..... 730.192, 730.193

Delineators consist of reflectors mounted on flexible posts or brackets. Reflectors are reflective sheeting adhered to either a flexible post or an aluminum plate. The colors of reflectors of each type are:

Type C	White
Type D	Yellow
Type E	Red

Delineator reflector and flexible post color shall match that of the nearest edge line.

620.03 Layout. Lay out all delineator locations to ensure their proper placement. The Engineer will approve the layout before installation is started.

620.04 Removal. Remove delineators, including reflectors, posts, brackets, and miscellaneous hardware. The delineator becomes the property of the Contractor. Remove and dispose of concrete for delineator post embedment.

Restore surfaces where delineator posts or concrete for embedment are removed.

620.05 Installation. Install delineators facing traffic, except install red reflectors facing wrong-way traffic. Do not remove the protective paper covering the face of flexible post-mounted reflectors until after installation. Ensure that posts are not more than 1:50 out of plumb. If soil conditions may cause the post to be out of plumb, the Contractor may drive a pilot shaft before installation.

Install flexible posts using methods and equipment that conform to the post manufacturer's recommendations.

620.06 Method of Measurement. The Department will measure Delineator by the number, including reflectors, supports and hardware, in place, completed and accepted.

The Department will measure Removal of Delineator, by the number.

620.07 Basis of Payment. The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
620	Each	Delineator
620	Each	Removal of Delineator

ITEM 621 RAISED PAVEMENT MARKERS (RPM)

621.01 Description
621.02 Materials
621.03 Layout
621.04 Installation RPM Casting
621.05 Installation RPM Retroreflector
621.06 Reflector Replacement
621.07 Reflector Color
621.08 Raised Pavement Markers Removed
621.09 Method of Measurement
621.10 Basis of Payment

621.01 Description. This work consists of preparing the pavement and furnishing and placing plowable raised pavement marker castings (RPMs) and prismatic retroreflectors, and removing existing RPMs for disposal.

621.02 Materials. Furnish materials conforming to :

Castings..... 721.01
Prismatic Retroreflectors and Adhesive..... 721.02
Casting adhesive 721.03

621.03 Layout. Before placing RPMs, lay out the location of all RPMs. Locate RPMs within 5 percent of specified spacing. Do not place RPMs under the following conditions:

A. On pavement surfaces with cracking, spalling, or failure of underlying base material.

B. Within 1 foot (0.3 m) of active signal detector loop wires. Exercise care to ensure that detector lead-in cables are not cut.

C. Over pavement markings except with the Engineer's approval.

D. Closer than 2 inches (50 mm) to a pavement construction (transverse or longitudinal) joint or within an intersection.

E. Within 3 feet (1 m) of a bridge expansion joint.

If the initial location of a RPM is determined to violate one of the aforementioned conditions, relocate the affected RPM longitudinally. Relocate the RPM within a distance not exceeding 25 percent of the specified RPM spacing. If necessary to relocate the RPM to a distance greater than 25 percent of the specified RPM spacing, do not install the affected RPM.

RPMs along double yellow centerline are to be placed in line, but no closer than 2 inches (50 mm) to a pavement construction (transverse or longitudinal) joint. RPMs installed along a channelizing line are to be placed no more than 1 inch (25 mm) from the edge of the painted line and no closer than 2 inches (50 mm) to a pavement construction (transverse or longitudinal) joint. Place the RPMs installed along a lane line or dashed yellow centerline between and in line with the dashes no closer than 2 inches (50 mm) to a pavement construction (transverse or longitudinal) joint.

Install replacement RPMs within 3 feet (0.9 m) longitudinally of the damaged or missing RPM.

621.04 Installation RPM Casting. Cut parallel slots with 1/16 to 1/8 inch (1.5 to 3 mm) clearance on each side for installing RPM castings.

Pavement cuts should be inspected prior to adding casting adhesive.

When a casting is inserted in the cut without casting adhesive to test proper cut, at least 3 of the 4 leveling lugs/tabs must contact the pavement surface and all four keel-ends of castings must be below the pavement surface.

Each casting must be centered lengthwise and should have 1/16 to 1/8 inch (1.5 to 3 mm) clearance between pavement cut and casting for casting adhesive to bond properly. Only the leveling lugs/tabs should be in contact with the pavement surface after insertion of casting in pavement so that a minimum of 1/16 inch (1.5 mm) of casting adhesive is the bonding adhesive between the casting and pavement. The casting adhesive must fill all voids.

The pavement cut must be completely dry and free of dust, dirt or any other material that will interfere with the adhesive bond to the casting and the pavement. Casting adhesive on the active reflector face must be removed immediately.

Install the RPM casting within 24 hours after cutting the slots into the pavement. On new pavement surfaces, the Contractor may begin RPM placement as soon as the pavement markings for that section are completed and dry.

Ensure that the RPM casting is free of dirt, dust, oil, grease, rust, moisture, or any foreign matter that impairs adhesion to the pavement.

Place RPMs when the pavement surface temperature and the ambient air temperature are at least 40 °F (5 °C) and the pavement is dry. Heat both parts of the RPM casting adhesive to 100 ± 10 °F (38 ± 5 °C) during installation when either the pavement surface or ambient air temperature is between 40 and 50 °F (5 and 10 °C).

Ambient Air Temperature		Minimum Period Protected from Traffic
°F	(°C)	Minutes
100	(38)	15
90	(32)	20
80	(27)	25
70	(21)	30
60	(16)	35
50	(10)	45
40	(5)	60

Do not allow traffic on the RPMs until the adhesive has cured.

Two component approved casting adhesive is used to fill the pavement cut to within approximately 3/8 inch (9 mm) of the top of the pavement cut. A minimum of 3 of the 4 leveling lugs/tabs must be in contact with the pavement surface and the casting adhesive should ooze out from under the casting from all sides filling all voids around the casting and be level with the pavement surface.

Mix the casting adhesive according to the manufacturer's recommendations. Complete the mixing operation and placing of the RPMs rapidly. Do not use any mixed batch that becomes so viscous that it cannot be readily extruded from under the RPM with light pressure.

621.05 Installation RPM Retroreflector. Attach the reflector to the casting before installation or after the adhesive in the pavement slots has cured.

Remove all dirt, dust, oil, grease, rust, moisture, parts of damaged reflectors, or any foreign matter that impairs adhesion of the reflector to the casting.

Peel the release liner from the back of the reflector with butyl pad. Apply a wide bead (approximately 3/8 inch (9 mm)) of reflector adhesive sufficient to squeeze out on all sides when pressure is applied to seat the reflector.

Apply approximately 100 pounds (45 kg) of pressure on the reflector or foot pressure for 1 to 3 seconds. Do not allow adhesive material on the reflective surface of the reflector. Any adhesive on the active reflector must be removed immediately.

Apply the reflector when the pavement surface temperature and the ambient air temperature are at least 35 °F (2 °C) and the casting surface is dry. Do not attach the reflector to the casting when rain over the work site is imminent.

621.06 Reflector Replacement. Replace damaged, non-retroreflective, or missing reflectors within the existing marker installations where the casting remains intact with the appropriate reflector type. The Engineer will determine the location of replacement reflectors.

Perform the cleaning and attachment procedure for replacing reflectors within existing RPM installations according to 621.05.

621.07 Reflector Color. Use the appropriate reflector color for the following applications:

A. Channelizing Lines. White/red two-way reflectors with white facing traffic.

B. Lane Lines. White one-way or white/red two-way reflectors as specified, with white facing traffic.

C. Edge Lines. One-way reflectors facing traffic matching the edge line color or two-way reflectors with the edge line color facing traffic and red in the opposite direction.

D. Center Lines. Yellow two-way reflectors.

621.08 Raised Pavement Markers Removed. As designated, remove existing raised pavement markers. Fill all depressions caused by removing the castings with asphalt concrete by the end of the next workday. Remove all standing water from the hole before filling. Compact the asphalt concrete flush with the pavement. Removed raised pavement markers become the property of the Contractor.

621.09 Method of Measurement. The Department will measure RPMs by the number of each furnished, complete with reflectors, in place, and accepted.

The Department will measure RPM, Reflectors by the number of each, complete in place, for use on existing RPM castings in the pavement, and accepted.

The Department will measure Raised Pavement Markers Removed by the number. Payment will include the cost of asphalt concrete to fill depressions caused by removal of the castings.

621.10 Basis of Payment. The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
621	Each	RPM
621	Each	RPM Reflector
621	Each	Raised Pavement Marker Removed

ITEM 622 CONCRETE BARRIER

622.01 Description. This work consists of furnishing and placing portland cement concrete barrier on the accepted and prepared subgrade, subbase course, or existing pavement. This item also consists of furnishing, placing, maintaining, and removing portable barrier.

622.02 Materials. Furnish materials conforming to:

Concrete,
Class QC 1 * 499
Reinforcing steel and wire fabric 509.02
Forms 515.14
Preformed filler 705.03
Curing materials 705.05, 705.06,
..... or 705.07 Type 2
Precast concrete 706.13
Dowel bars ..... 709.01 thru 709.05
Steel 711.01

* Replacing Coarse aggregate in the concrete mixes with Recycled Concrete Aggregate conforming to Supplement 1117 is an option

622.03 Placing Concrete. Construct concrete barrier by cast-in-place, precast, or slip-form methods. For slip-form construction, conform to 609.04.C.

622.04 Portable Barrier. Furnish individual sections not less than 10 feet (3 m) long. If intending to use the barrier at one location on the project, the Contractor may slip-form barriers in place without joints, or with grooved or sawed joints to facilitate removal. As directed by the Engineer, repair or replace barrier sections damaged during handling or by traffic, for the life of the project. The Contractor may substitute approved proprietary portable barrier products which can be found on the Office of Roadway Engineering's website. Obtain the Engineer's written approval before substituting a proprietary portable barrier that requires anchoring for an unanchored portable barrier on a bridge deck.

622.05 Joints. Construct joints for cast-in-place or slip-formed barrier of the type and dimensions and at the locations specified.

A. Contraction Joints. The Contractor may construct unsealed contraction joints by either sawing, using metal inserts inside the forms, using a grooving tool, or using full-width 3/4 inch (19 mm) thick preformed joint filler conforming to 705.03. Make joints that are sawed, tooled, or formed by inserts a minimum of 1/8 inch (3 mm) wide and 3 inches (75 mm) deep. Saw joints as soon as curing allows sawing to the required depth with minimal spalling of the concrete surface.

B. Expansion Joints. Use 3/4 inch (19 mm) preformed joint filler conforming to 705.03 to construct expansion joints at locations as shown in the plans.

C. Horizontal Construction Joints. If and as shown on the plans, the Contractor may place horizontal construction joints.

622.06 Finish. Immediately following removal of fixed forms or slip-form construction, check the surface of the barrier with a straightedge and correct all irregularities of more than 1/4 inch in 10 feet (6 mm in 3 m). Finish and make corrections to the barrier surface according to 511.18.

622.07 Curing. Cure concrete according to 511.14, Method B and the following additional requirements. Apply the curing compound using an approved mechanical sprayer equipped with a shield to protect the spray from wind. For small areas, the Engineer will allow the use of other acceptable methods.

Do not apply any load or conduct any work that will damage newly placed concrete. Allow a minimum of 36 hours of cure time to elapse on any concrete placed first at a horizontal construction joint. The Contractor may cure precast sections according to 515.15. With the Engineer's approval, the Contractor may also use radiant heated forms for curing.

The Contractor may use 511.14, Method A for curing of short sections of barrier (leave-outs); however, before the curing is completed for any leave-outs, apply material conforming to 705.07, Type 2 at the normal rate specified in 511.14, Method B.

The Contractor may cure horizontal construction joints between the foundation and the upper portion of the barrier, and between portions of the upper barrier placed separately according to 511.14, Method A or B. Do not remove the membrane before placing the next portion of the concrete barrier.

622.08 Method of Measurement. The Department will measure Concrete Barrier by the number of feet (meters) along the centerline of the top of the barrier, including all transitions, and bridge pier sections as specified, complete in place excluding end anchorages and excluding sections.

The Department will measure Reinforced End Anchorages of the type specified by the number each complete in place.

The Department will measure End Sections of the type specified by the number each complete in place.

The Department will measure Portable Barrier Anchored, Portable Barrier Unanchored, Portable Barrier 50" (1270mm) and Portable Barrier 50" (1270mm) Bridge Mounted by the number of feet (meters) for each application of the barrier placed according to the plans. The Department will measure each re-use of barrier sections at a different location required by the plans separately.

The Department will not measure repaired or replacement barrier sections damaged during handling or by traffic.

622.09 Basis of Payment. The cost of all inserts, sleeves, fittings, connectors, reinforcement, dowels, preformed filler, excavation, aggregate base, and backfill is incidental to these items. Anchoring required for approved proprietary portable barrier products when substituted for Portable Barrier, Unanchored, is incidental to the pay item. Transitions to and from Portable Barrier (Anchored or Unanchored), including all items necessary for the transitions are incidental to the pay item.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
622	Foot (Meter)	Concrete Barrier, Type ___
622	Each	Concrete Barrier End Anchorage, Reinforced, Type ___

622	Each	Concrete Barrier End Section, Type ____
622	Foot (Meter)	Portable Barrier, Unanchored
622	Foot (Meter)	Portable Barrier, Anchored
622	Foot (Meter)	Portable Barrier, 50" (1270 mm)
622	Foot (Meter)	Portable Barrier, 50" (1270 mm) Bridge Mounted

ITEM 623 CONSTRUCTION LAYOUT STAKES AND SURVEY MONUMENTS

623.01 Description. This work consists of furnishing the accurate horizontal and vertical locations for the construction of the Work shown in the contract documents. Acceptable methods include, placing, and maintaining construction layout stakes, real time layout utilizing survey equipment (GPS, Total Station, Level) and automated machine control and guidance. This work also includes verification, placement, protection, and any necessary restoration of project control monuments, monument assemblies, reference monuments, right-of-way monuments, property line/boundary monuments and other survey monuments.

Use Geodetic and/or Primary Project Control monuments as the basis for all construction layout staking and verification, placement, protection, and restoration of survey monuments. Ensure that all work encompassing the verification, placement, protection, and restoration of survey monuments is performed under the supervision of a Registered Surveyor and certify that the accuracy of all measurements meets Ohio Administrative Code Section 4733-37 and the ODOT Survey and Mapping Specifications. Ensure all construction layout is performed under the supervision of either a Registered Surveyor or a Registered Engineer.

623.02 Materials. Furnish materials conforming to:

Concrete, Class QC Misc or QC 1	499
Cast frames and covers	711.12, 711.13, or 711.14
Concrete sand (fine aggregate)	703.02.A
Stainless steel bolts	730.10
Steel rods	709.01
Pipe	706.07, 706.09, or 707.45

623.03 Definitions

A. Geodetic/Primary Project Control Monument. A monument which is constructed by ODOT or its Design consultant and is positioned in compliance with the ODOT Survey and Mapping Specifications.

B. Survey Monuments. Includes primary project control monuments (including azimuth marks and temporary benchmarks), monument assemblies, centerline monuments, centerline reference monuments, Right-of-Way monuments, property line/boundary monuments and local, state or federal geodetic control monuments.

C. Monument Assembly. A monument typically within paved areas, that consists of a steel rod housed inside a monument assembly with a cast frame and cover according to SCD RM-1.1 that is used to define a geometric position of a point on the centerline of Right-of-Way or a point of common report such as a section corner, lot corner, or VMS corner.

D. Centerline Monument. A monument typically outside of paved areas that consists of a steel rod and aluminum cap encased in concrete according to SCD RM-1.1 where the surveyed position defines a geometric point on the centerline of Right-of-Way.

E. Centerline Reference Monument. A monument outside of paved areas that consists of a steel rod and aluminum cap encased in concrete according to SCD RM-1.1, where the surveyed position references a geometric point on the centerline of Right-of-Way with a known bearing/station and offset distance.

F. Right-of-Way Monument. A property boundary monument set according to SCD RM-1.1 to comply with Ohio Administrative Code Section 4733-37, "Standards for Boundary Surveys in the State of Ohio" and recited in the Right-of-Way deeds to convey property or easement rights. Right-of-Way monuments are set at property corners, property line intersections, points along the Right-of-Way and angle points on the Right-of-Way.

G. Azimuth Mark. A project control monument set for use as a "backsight" point.

H. Temporary Benchmark. A monument with an elevation transferred from a primary project control monument used for construction layout purposes only.

623.04 Survey Monument Verification. Verify the position of survey monuments shown in the Contract Documents including the project control and those shown in the right-of-way plans and locate any additional survey monuments if discovered within the right-of-way in the project work area . Generate a report detailing the surveyed location of all monuments. Use standard acceptable surveying measurement techniques suitable to meet the requirements of Ohio Administrative Code Section 4733-37, "Standards for Boundary Surveys". Survey monument verification is required on all projects where survey monuments are specified in the Contract Documents including pavement resurfacing, reconstruction and repair projects where monument assemblies will be adjusted or reconstructed to grade.

Use the Department's standardized verification report template. The "Survey Monument Verification Report" template can be downloaded from the following website:

www.dot.state.oh.us/divisions/constructionmgt/admin/pages/default.aspx.

A. Preconstruction Survey Monument Verification. Preconstruction Survey Monument Verification is performed to identify any discrepancies or changes to the usability of the project control monuments specified in the Contract Documents and to identify all required survey monuments within the right-of-way in the project work area that could be damaged or destroyed by construction activities. If additional survey monuments are discovered within the right-of-way in the project work area and are not shown in the Contract Documents, locate, protect, reference, and preserve them in the same manner as survey monuments in the Contract Documents. Include the additional survey monuments in the Survey Monument Verification Report. Perform this work before beginning earthwork, resurfacing, or construction activities. Have a Registered Surveyor prepare a Survey Monument Verification Report detailing the point number, surveyed coordinates, station, offset, a description of each survey monument found and the calculated differences in the Northing, Easting and Elevation from the plan location. Descriptions should include the size, material, condition, depth and any cap stamping or markings. Any differences between plan and observed coordinates exceeding 0.10 feet will be highlighted for remediation as approved by the District Survey Operation Manager and detail remedial actions for each necessary monument in the Survey Monument Verification Report. Have the Registered Surveyor sign, seal, and date the Survey Monument Verification Report and submit it to the Engineer and the District Survey Operations Manager.

Unless required by the District Survey Operations Manager, Preconstruction Survey Monument Verification is not required for projects without project control monuments and when the anticipated work only requires adjustment or reconstructing monument assemblies to grade without direct changes to the monument within the assembly.

B. Post Construction Survey Monument Verification. Post Construction Survey Monument Verification is performed to ensure that all required survey monuments as specified in the Contract Documents, and additional monuments found during the Preconstruction Survey Monument Verification, are preserved, set, reset, and/or adjusted to grade. Perform this work after completion of final grading and/or resurfacing and construction activities. Have a Registered Surveyor prepare a Survey Monument Verification Report detailing the point number, surveyed coordinates, station, offset, and a description of each survey monument. Include the size, material, condition, depth any cap stamping or markings, and calculate the differences in the Northing, Easting and Elevation from the plan location. Differences exceeding 0.10 feet will be highlighted for remediation as approved by the District Survey Operation Manager and detail remedial actions for each necessary monument in the Survey Monument Verification Report. Have the Registered Surveyor sign, seal and date the Survey Monument Verification Report and submit it to the Engineer and the District Survey Operations Manager. Post Construction Survey Monument Verification is required for standard resurfacing

projects for all monument assemblies adjusted or reconstructed to grade. Primary Project Control Monuments do not require post construction verification unless specified by the Contract Documents or requested directly by the Engineer

623.05 Placement, Protection and Restoration of Survey Monuments. Construct or replace all required survey monuments specified in the Contract Documents. Do not disturb survey monuments, cornerstones, or boundary monuments during construction unless specified in the Contract Documents. Restore survey monuments damaged or destroyed by construction activities, unless directed otherwise by the Engineer. Restore damaged survey monuments at locations specified in the Contract Documents or in their original location if the monument was not included in the Contract Documents. For a survey monument that cannot be installed in the location shown on the plans, notify the Engineer who will contact the District Survey Operations Manager to provide direction. Report monuments placed in locations other than in the specified locations in the Post Construction Survey Monument Verification Report. Do not place a monument in an alternate location without the prior approval of the District Survey Operations Manager. Refer to the Department's Real Estate Manual, Appendix K, for guidance on how to proceed with setting monuments in alternate locations.

623.06 Geodetic/Primary Project Control. Geodetic/Primary Project Control governs all positioning for Department projects. Use project control information provided on the plans for all project related survey operations.

623.07 Right-of-Way Staking. Stake Right-of-Way lines where work will be performed before beginning the work. Stake Right-of-Way lines by placing tall stakes, properly identified and readily discernible, at points of change in width or direction of the Right-of-Way line and at points along the line so that at least two stakes can be seen distinctly from any point on the line. The Engineer will not require the Contractor to set additional stakes to locate a utility line that is not included as a pay item in the contract, or to determine the property line between properties.

623.08 Construction Layout. Construction Layout will be performed in a manner to allow the contractor to properly construct the improvements on, below and above the ground at locations as defined by the contract documents and to allow for proper verification of said locations by the Department. All layout work will be relative to the Geodetic/Primary Project Control monuments. Applicable methods include, but are not limited to the following:

A. Furnish construction layout hubs, nails and stakes as required to construct the project per the Contract Documents.

B. Automated machine control and guidance utilizing alignments and models defined by the project plans included in the Contract Documents.

C. Real time layout by GPS, Total Station or Leveling Device per the Contract Documents and relative to the Geodetic/Primary Project Control monuments.

Submit a copy of the construction layout notes and raw data files to the Engineer upon request. The construction layout notes must contain enough information for the Engineer to verify the construction layout.

The Contractor is responsible for having the finished Work conform to the lines, grades, elevations and dimensions shown on the plans. Any inspection or checking of the Contractor's layout by the Engineer and the acceptance of all or any part of it does not relieve the Contractor of that responsibility.

The removal of construction layout stakes at the completion of the Work is a final cleanup item that is required as a condition of full payment for Item 624 Mobilization.

623.09 Providing Electronic Instrumentation. If specified as a pay item, provide the Engineer with electronic instrumentation so that the Department can verify the construction layout, perform check sections, and document pay items. Provide a survey-grade, global navigation satellite system (GNSS) receiver and data collector. Provide equipment that meets the requirements of the Department's Survey and Mapping Specifications.

Provide equipment, software, and all three-dimensional models needed to verify layout, perform check sections, and document pay items. Train the Engineer on how to use the provided equipment and software and provide technical assistance during the duration of the Work.

Upon completion of the Work, the electronic equipment, computer and software will remain the property of the Contractor.

If using GNSS methods to construct the project and a pay item for providing electronic instrumentation is not specified, provide the Engineer with the three-dimensional models in electronic format when requested. Provide the models at no additional expense to the Department.

623.10 Method of Measurement. Estimated unit quantities for constructing new monuments, adjusting or reconstructing monuments to grade, and replacement of Survey Monuments expected to be destroyed are included in the Contract Documents. The Contractor will be compensated on a unit basis for additional survey monuments found, located, and reconstructed or replaced within the right-of-way in the project work area but not shown on the plans.

Survey Monuments on or outside of the Construction Limits are the Contractor's responsibility to protect and restore as required. The Department will not pay for restoration of these items.

623.11 Basis of Payment. Payment for lump sum Construction Layout Stakes and Surveying includes payment for Construction Layout, Right of Way staking, and Placement, Protection and Restoration of Survey Monuments. Payment for lump sum items Pre/Post Construction Survey Monument Verification and Report includes payment for all surveying necessary to locate, verify and report survey monuments in Survey Monument Verification. The Department will consider the cost of locating new survey monuments to be included in the unit price bid for the survey monument.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
623	Lump Sum	Construction Layout Stakes and Surveying

623	Lump Sum	Providing Electronic Instrumentation
623	Each	Primary Project Control Monument, Type A
623	Each	Primary Project Control Monument, Type B
623	Each	Monument Assembly, Type C
623	Each	Monument Assembly, Type D
623	Each	Monument Assembly, Adjusted to Grade
623	Each	Monument Assembly, Reconstructed to Grade
623	Each	Monument Assembly Removed and Reset
623	Each	Reference Monument, Type A
623	Each	Right of Way Monument, Type B
623	Lump Sum	Preconstruction Survey Monument Verification and Report
623	Lump Sum	Post Construction Survey Monument Verification and Report

ITEM 624 MOBILIZATION

624.01 Description
624.02 Limitation
624.03 Method of Measurement
624.04 Basis of Payment

624.01 Description. This work consists of the preparatory work and operations including, but not limited to, those necessary for the movement of personnel, equipment, supplies, and incidentals to the project site; for the establishment of all field offices, buildings, and other facilities necessary for work on the project; for all other work and operations that must be performed or costs incurred before beginning the Work on the other contract items; and for demobilization.

If Mobilization is not included as a pay item in the Contract, the Department will not pay for this work separately but will consider it incidental to the other Contract Items.

624.02 Limitation. The Department will limit the sum of the partial payments specified in 624.04.A and 624.04.B to the amounts shown in Table 624.02-1 under "Maximum Total of Partial Payments". The Department will pay the balance of the lump sum amount bid, as specified in 624.04.C.

TABLE 624.02-1

Total Contract Amount		Maximum Total of Partial Payments
More than	Up to, inclusive	
($)	($)	($)
0	50,000	0
50,000	100,000	2,000
100,000	200,000	4,000
200,000	500,000	10,000
500,000	1,000,000	20,000
1,000,000	2,000,000	40,000
2,000,000	5,000,000	100,000
5,000,000	10,000,000	200,000
10,000,000	20,000,000	400,000
20,000,000	40,000,000	800,000
40,000,000	60,000,000	1,200,000
60,000,000	80,000,000	1,600,000
80,000,000	--	2,000,000

If the lump sum amount bid for Mobilization exceeds the total shown in Table 624.02-1 for partial payments, the Department will pay the excess upon completion of the project.

624.03 Method of Measurement. The Department will measure Mobilization as a unit, acceptably performed.

624.04 Basis of Payment. The Department will make partial payments according to 109.09 and as modified by the following schedule:

A. The Department will release 50 percent of the lump sum amount bid for Mobilization or 50 percent of the amount shown in 624.02, whichever is less, to the Contractor with the first estimate payable, but not sooner than 15 days after the start of work at the project site.

B. The Department will release an additional 40 percent of the lump sum amount bid for Mobilization or 40 percent of the amount shown in 624.02, whichever is less, with the first regular estimate after 10 percent of the original total contract amount, including payments for delivered materials but excluding Mobilization, is earned.

C. Upon completion of all work on the project, including final cleanup, the Department will release payment of the remaining 10 percent of the lump sum amount bid for Mobilization and any amount of the lump sum price bid for Mobilization, in excess of the total amount shown in 624.02 for partial payment. Final cleanup includes but is not limited to the removal of construction layout stakes and sediment and erosion control items.

The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
624	Lump Sum	Mobilization

ITEM 625 HIGHWAY LIGHTING

625.01 Description. This work consists of furnishing and installing highway lighting equipment complete and ready for service. This work shall also include necessary excavation and backfill, disposal of discarded materials, restoration of disturbed facilities and surfaces, and testing as specified.

625.02 Definitions. Lighting terminology herein is defined in the American National Standard Practice for Roadway Lighting.

625.03 Codes. Follow the National Electrical Code, as adopted by the State of Ohio, The National Electrical Safety Code and local codes where applicable.

625.04 Permits. Obtain all permits required as an incidental to the construction of the lighting installation.

625.05 Materials. Furnish materials conforming to:

Concrete QC Misc or QC 1	499, 511
Reinforcing steel	509.02
Sand	703.06
Cable	725.02
Unit type duct-cable systems	725.03
Conduit	725.04, 725.051, 725.052
Pull boxes	725.06, 725.07, 725.08, 725.12
Junction boxes	725.10
Luminaires	725.11
Lamps	725.11

625.06 Shop Drawings. Submit, to the Engineer prior to incorporation, two copies of the shop drawings and catalog cuts which identify and describe each manufactured item which is being incorporated into the construction. Certify in writing that each manufactured item is in conformance with all contract requirements for that item. Ensure that the documents describing each item indicate the project number (including the construction year) and the bid reference number under which the item is being installed and that the documentation contains all of the information needed to allow the Engineer to determine that the item to be supplied meets all applicable requirements along with all of the information needed by the maintaining agency to obtain an identical replacement unit from the manufacturer. When a given item is to be incorporated into the construction under multiple bid item reference numbers, furnish a separate and complete documentation package for each bid item reference number under which the item is to be installed. When multiple items are to be incorporated under a single bid reference number, submit the documentation for all such items together.

625.07 Incidentals. Furnish and install all incidentals necessary to provide a complete and practical working unit or system.

625.08 Luminaires. A luminaire consists of a housing with a lamp, a lamp socket, the optical components to direct the output from that lamp, and the electrical components needed to operate the lamp.

Ensure that luminaires of the same type (i.e. high mast, low mast, conventional, underpass, post top, etc) in a given installation (i.e. interchange, rest area, weigh station, etc.) are of the same brand.

Align each luminaire vertically and horizontally to the roadway as specified. Where the profile grade exceeds 4 percent and the luminaire is mounted less than 60 feet (18 m) above the roadway, adjust the luminaire to be perpendicular to the roadway rather than gravimetric level.

At the locations designated in the plans or as directed by the Engineer, furnish and install glare shields obtained from the manufacturer of the luminaire.

Apply a clearly-visible, liberal coating of metal-free molybdenum disulfide and graphite-based anti-seize compound to all fasteners used in accessing the lamp for replacement.

After all other work has been completed, clean the reflector, refractor and other components of the optical assembly just prior to leaving the job.

625.09 Luminaire Supports. Luminaire supports fall into three categories: bracket, light pole, light tower.

A bracket is the attaching hardware used to mount a luminaire onto the face of a wall or pier cap, or hang a luminaire from the bottom of a deck or beam or other similar installation. A bracket is often supplied for the luminaire by the luminaire manufacturer to facilitate the installation of the luminaire. A more complex situation will require extensive work to fabricate a bracket for the situation.

A light pole is the pole with one or more fixed brackets or arms for supporting luminaires above the roadway to be lighted. A light pole also includes a lower portion of the pole which is embedded or a mounting plate, any base for housing components or wiring, and when specified a breakaway device such as a frangible base, frangible couplings or slip plates.

A light tower is a shaft with a base plate, head frame, ring or similar structure on which one or more luminaires are mounted with a mechanism for lowering the mounting ring and luminaires for servicing and a lightning protection system.

Ensure that luminaire supports of the same type (i.e. high mast, low mast, conventional, underpass, post top, etc.) in a given installation (i.e. interchange, rest area, weigh station, etc.) are of the same brand.

Plumb each light pole and each light tower. When shims are used, use only shims of an approved design and installed in an approved manner. Do not install more than the minimum number needed to plumb the pole and neither exceed the maximum allowed total thickness of the shim pack nor the maximum number of shims permitted. When leveling nuts are used, ensure that such nuts are installed in approved locations and that both the anchor and the leveling nuts are properly tightened according to AASHTO LTS-6 (*Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals,* 2013) section C5.17.5.2.

Ensure that the grounding connections for each light pole or light tower have been made and that the resultant ground is within the earth resistance limit specified

Apply a suitable lubricant to prevent seizing to each cover fastener and install all such fasteners.

After erection, the Engineer shall inspect each pole for defects in the surfaces and determine for each defect discovered whether the defect is minor enough that the Contractor may be allowed to field repair the finish or major enough that the Contractor must replace the pole. Make finish repairs and provide and install replacement poles as directed by the Engineer for no additional charge to the project.

Label each light pole and light tower with the alpha numeric identifier. Place the identifier on the quadrant of the surface of the pole that faces oncoming traffic at approximately 7 feet (2 meters) above the roadway surface. Apply the identifier letters and numerals when the ambient air temperature, the temperature of the labeling material and the temperature of the surface to which the labels are applied are all above 40° F (4° C). Identification of the light poles or light towers and the removal of any previous such identifier in the case of light poles or light towers being reassigned shall be considered as incidental work.

625.10 Foundations. Excavate for each foundation to the dimensions given.

If a cave in should occur during excavation, excavating using casing, sleeving or other methods may continue with the approval of the Engineer.

Where, in the opinion of the Engineer, the excavation for a foundation has revealed an unstable condition at the bottom of the excavation, drill the foundation shaft deeper, enlarge the diameter of the drilled shaft, or make other modification to the foundation as directed by the Engineer who shall initiate the appropriate arrangements to compensate the Contractor for the addition work required.

When rock is encountered, continue excavation to a minimum of 3 feet (1 meter) into rock. The Engineer may then decrease the total depth of the foundation to not less than 6 feet (2 meters) for a light pole or 10 feet (3 meters) for a light tower.

Reinforce each foundation with steel as specified and such steel reinforcing shall be placed in accordance with 509.

Install the anchor bolts for the light pole or light tower in each foundation using anchor bolt setting templates.

Place Class QC Misc or QC 1 concrete for the foundation in accordance with 511 except that forms will not be required for portions of foundations extending more than 6 inches (150 mm) below the ground line, unless the soil does not have sufficient stability to stay in place during the placing of the concrete.

Finish the top of each foundation smooth and level.

After forms have been removed, backfill the excavated spaces around each foundation with suitable material placed and tamped in thin layers as directed by the Engineer.

625.11 Junctions Boxes (Handholes) & Pull Boxes (Manholes).

Furnish and install a junction box of the size and type specified. Furnish each junction box embedded in concrete with a drain. Lubricate each cover screw with a compound to prevent the screw from seizing and install all cover screws.

Furnish and install a pull box of the size and type specified. Excavate for each pull box as nearly as practicable to the outside dimensions of the pull box. Install a 6 inch (150 mm) gravel base with a 4 inch (100 mm) underdrain to a suitable outlet below each pull box. After setting the pull box to proper grade, backfill the excavated spaces around the pull box with suitable material placed and thoroughly tamped in thin layers.

When a pull box is to be installed in a paved area, remove an adequate area of the paving by saw cutting the sides of the area to be removed, or by removal of the paving back to an expansion joint as instructed by the Engineer. After setting the pull box to proper grade, backfill the excavated spaces around the pull box with suitable material placed and thoroughly tamped in thin layers, and restore the pavement base and paving to match the surround.

Metal pull box lids shall be bonded by attachment of the equipment grounding conductor to the frame diagonal and a braided strap.

625.12 Raceways and Conduits. Furnish and install conduit of the sizes and types specified. When the location, type or size of a conduit has not been indicated, submit to the Engineer working drawings showing the location and size and type of each such conduit along with the number and size of wires contained in each such conduit and secure the approval of the Engineer prior to installing the conduit. Use of conduit material shall comply with the NEC.

When not otherwise specified, all conduit and fittings on an individual run of conduit shall be of the same material except for approved manufactured transition fittings required at end of the run when the item into which the conduit terminates is not of the same material as the conduit. HDPE conduit shall not be used where exposed, or within buildings.

Install each conduit with a minimum amount of bending and ensure that the total bending between adjacent access points (junction boxes, pull boxes, light poles, control equipment enclosures, etc.) does not exceed 270 degrees. Do not bend any conduit to a bend radius of less than 12 times the internal diameter of the conduit. Bend each conduit in such a manner as to avoid damage to the conduit and any protective coating and such that the internal diameter of the conduit will not be reduced.

Use watertight hubs for all conduit penetrations of outdoor electrical enclosures. Do not make such penetrations using locknuts onto threaded conduit ends.

Remove the rough edges from the cut end of each conduit. In addition, ream the cut end of each metallic conduit. Bush each end of each conduit to further protect the wire insulation and cable jackets from damage.

Where threads have been cut onto ferrous metallic conduit after galvanizing, paint the threaded area with a UL-Listed anti-corrosion compound in such a manner that there will be no unprotected surfaces.

Make each conduit joint tight to provide structural integrity in all conduits and to electrically bond the jointed sections of metallic conduit. Provide an equipment grounding conductor that is not in a jacketed cable assembly in metallic conduits when not otherwise available and bond the conduit to this grounding conductor.

Securely fasten onto or build into the structure each conduit.

Install the appropriate expansion or deflection joint in each conduit at all locations where movement must be accommodated (such as expansion joints on structures) and install suitable bonding to assure electrical continuity of the grounding system.

Bond all metallic items enclosing electrical conductors together and to good earth ground.

Furnish each enclosure, junction box, pull box and conduit with a drain. When the low point of a conduit does not occur at a drained access point, install a T coupling at the low point of the run and route the side outlet to drain.

Where underground conduits are to be encased in concrete, use Class QC Misc or QC 1 concrete and furnish a minimum of 3 inches (75 mm) of concrete on all sides using spacers.

After installation of the conduit and prior to installing the cables, run a mandrel whose diameter is at least 90% of the interior diameter of the conduit through the conduit.

If the new conduit contains cabling, install a flat woven polyester pulling tape, rated for 600 pound minimum, in the conduit.

If the new conduit is to remain empty, install an HDPE insulated copper tracer wire, 12 AWG minimum, in the conduit. Allow for 10 feet of slack in each adjacent pull box.

Temporarily seal the ends of a conduit immediately after placement of conduit when the conductors or cable cannot be installed promptly.

After installing the wire or cable and conduit bushings, seal all open conduit ends. Use polymer-based, mineral-filled reusable non-drying elastic duct sealing putty identified for use with the cable insulation, shield or other components. Do not use expanding foams or foam of any kind.

625.13 Trenching. Follow the routing shown on the plan. Keep the trench within 6 inches (150 mm) of the designated line where the trench is adjacent to and parallel with a curb or pavement.

In unpaved areas, a plow may be used in lieu of trenching with the approval of the Engineer. Use a machine that can install the duct uniformly at the specified depth without stretching or abrading the duct and which leaves a narrow self closing slit which presents no significant hazard during the self closing period.

In unpaved areas, make the trench a minimum of 2 feet (0.6 m) deep and not more than 12 inches (300 mm) in width. Backfill the trench in layers not more than 6 inches (150 mm) in loose depth and compact each layer with a mechanical tamper or other approved method as directed by the Engineer. Use suitable soil to backfill a trench in earth. Use granular material to backfill a trench in an aggregate or in chemically stabilized subgrade. Ensure that the backfill material around and in the first 4 inches (100 mm) above the top of unit type duct cable not encased in concrete is sand or earth with no stones larger than 1/2 inch (13 mm).

In paved areas, either make a slit or T type trench. Cut the pavement along existing joints or grooves where possible. Mark the pavement with cut lines and secure the Engineer's approval of the location of the cut before cutting the pavement.

625.14 Jacking and Boring. In addition to the requirements of 625.12 to furnish and install conduit, use jacking or horizontal boring when the plan calls for such methods to be used. Use these methods in lieu of trenching only with the approval of the Engineer.

Jack only rigid galvanized steel conduit. Use only a machine designed for jacking conduit not the bucket or blade of a machine designed for earthwork.

Horizontal boring may be used to install any conduit or duct which has the adequate strength, flexibility and joints to withstand the process. Make the diameter of the bore no more than 20 percent larger than the outside diameter of the conduit or duct being installed.

625.15 Power Service. Furnish and install all equipment necessary to provide a complete electrical service to the roadway lighting facilities. Follow the National Electrical Code (NEC) Article 400 for enclosures, in the construction of all enclosures for power service and lighting control centers.

The power service equipment includes, but is not necessarily limited to: poles or other support structure for the mounting of the equipment, hardware for dead ending an overhead service drop or trench and conduit for receiving an underground service line, NEC Article 285 Type 1 (Surge Arrestor) surge protector device (SPD), meter base, customer service disconnect, magnetically held lighting contactor, photoelectric cell and Hand-Off-Automatic switch for control of contactor, overcurrent protection devices for each individual lighting circuit, enclosures, conduits, fittings, cables and connectors.

Assure all control equipment included in the power service is capable of operating within the provided enclosure(s) over appropriate temperature and humidity conditions. Assure that power service equipment that includes daytime lighting controls shall operate continuously with the enclosure placed in a location fully exposed to sunlight and daytime temperature of 100°F ambient.

Construct the lighting electrical system to provide selective coordination of overcurrent devices per NEC 240.12(1). Overload indications per NEC 240.12(2) are allowed but not required as part of a standard ODOT lighting control system. Provide to the Engineer:

A. individual catalog sheets and device time-current curves and/or tables and

B. combined graphical overlays that document acceptable installed overcurrent device coordination.

Provide this documentation for all installed overcurrent devices, including the service disconnect fuses, the lighting control center branch circuit breakers, and tower circuit breakers/ pole fuses (if present). Tabular data, if used, shall include the following time points as a minimum: 0.01, 0.02, 0.05, 0.1, 0.2, 0.5,1, 10, 100, and 300 seconds and additional points as needed to clearly show the overcurrent device operating characteristics. Include minimum melt time and maximum clearing time for fuses; include minimum and maximum clearing time for circuit breakers. Provide documentation of the utility-installed transformer ANSI fuse link type (e.g., K or T) and fuse rating (if available). Provide documentation of the utility-installed power service size (in kVA).

Provide to the Engineer a compiled list or catalog sheets showing the Short-Circuit Current Rating (SCCR) of all fuses and fuse holders, circuit breakers, switches and contactors, pursuant of the requirements in NEC Article 110.10

If the power service has multiple enclosures, mark each enclosure in white letters engraved on a black plastic placard with the function of the equipment contained therein such as “SERVICE DISCONNECT”, “LIGHTING CONTACTOR”, “LIGHTING PANEL”, or other appropriate designation. Apply a durable, weatherproof adhesive arc and shock hazard warning label to the outside of each electrical enclosure that contains applicable voltage and/or arc hazard levels.

When an apparatus enclosure contains circuits above the 600 volt class, mark the enclosure in white letters on a red plastic placard with the warning "DANGER-HIGH VOLTAGE" on each enclosure door.

Install each photoelectric cell facing North unless the Engineer directs that a specific cell face otherwise to reduce interference from surround lighting.

Bond all metallic portions of the supporting structure, equipment housings and conduits properly and to an adequate earth ground.

Install a wood or plastic wire moldings from grade to 3 feet (1 meter) above grade over any grounding cables installed on a wood pole.

Coordinate and cooperate with the power company in the making of the connections to establish electrical service. Charges made by the power company for establishing of the account, extension of company facilities, connection of customer equipment to the power company facilities and energy will be borne by the maintaining agency. This compensation is for invoiced cost without mark-up.

Install a padlock per 631.06 on all external actuators. Coordinate with power company on installation of a second padlock conforming to their specifications. Install a dual padlock bar.

625.16 Grounding. Connect each light pole or light tower to a local earth ground.

Connect each power service to a local earth ground.

Provide continuity of grounding by bonding the metallic portions of fixtures, apparatus enclosures, supports, conduits, raceways, junction boxes and pull boxes together and connecting to earth ground. At a light pole or a light tower, install a bonding cable between the grounding bushing on each metal conduit and the ground lug or bolt in the pole base. At a junction box or a pull box, install a grounding bushing on each metallic conduit not bonded to the box through the conduit connector, and install a bonding cable between the grounding bushings on the conduits and the ground lug or bolt in the box.

For a light pole, light tower, power service or other such item mounted independently, install one or more grounding electrodes.

For a luminaire, light pole, light tower, switch enclosure, or other such item mounted in or on major highway structures (i.e. bridges), connect the item to the structure grounding system.

For a lighting contactor, lighting circuit panel or other such item mounted in a building (i.e. motorists services building, weigh station scale house, etc.), connect the item to the grounding system provided for the building.

For each bridge, wall, or other structure having electrical elements contained therein or attached thereto, furnish all materials necessary including grounding electrodes and install a complete structure grounding system to bond all exposed metallic portions of the structure (i.e. beams, railings, etc.) electrically together and connect those items to good earth ground. In the case where structures are separate but adjacent, connect the multiple structures together to avoid any difference in earth potential between the structures.

Make the permanent connection between the ground rod and the grounding conductor by exothermic welding.

If the earth resistance measurement exceeds 10 ohms for a ground for a traffic signal controller or a light tower or 25 ohms for any other ground, install a second ground rod at least 10 feet (3 meters) from the first and temporarily connect the second rod to the first. If the earth resistance still exceeds the above specified values, permanently connect the first two rods using the same type of cable used for the grounding conductor and continue to add rods one at a time as directed by the Engineer.

Where rock does not permit the driving of ground rods, develop an earth connection by constructing a grid from the partially driven rods supplemented by buried bare cable as directed by the Engineer.

625.17 Wiring and Cabling. Furnish and install electrical wires and cables of the types and sizes required with no in-line splices between terminations at devices unless specifically called for by the plan or directed by the Engineer.

Install wire mesh cable grips on vertical runs of wire or cable in poles and attach said grips to the "J" hook at the tops of the poles in such a manner as to prevent the weight of the vertical run from abrading the wire insulation or cable jacket where the wire or cable passes into or from the pole.

Identify all wires and cables, except bare ground bonding cables, as to circuit and function with tags or bands in the base of each light pole or light tower, each junction box or pull box, each apparatus cabinet, and other similar locations.

Pay out each wire, cable and duct cable by "unwinding" it from the shipping reel, spool or coils and not allow the wire cable or duct-cable to "spiral" from off the side of the spool reel or coil. In addition when wire cable or duct cable is being placed in trench, move the reel spool or coil along the side of the trench to allow the wire or cable to pay out into the trench as directly as practical. Seal the ends of each run of duct cable in the same manner as conduit as each run is installed.

Do not install duct cable when the temperature of the duct-cable cannot be kept above 32 °F (0 °C) except with the permission of the Engineer.

If the end of a wire or cable or duct must stand exposed to the elements or construction activities, protect said exposed end by enclosing it in a plastic bag or wrapping it with tape until the termination or connection can be made.

625.18 Connections. Make each wire and cable connection above grade (i.e. bases of light poles or light towers, junction boxes on structure or in concrete barrier medians, etc.) with an approved cable connector kit. Use quick disconnect type kits in the base of each light pole with a fused type in each line or phase conductor. Plug unused line side wire opening in each connector kit installed in the base of the light pole at the outer end of a circuit.

Make each cable connection below grade (i.e. pull boxes, junction boxes in retaining walls, etc.) with a cable splicing kit.

Protect partially assembled connections from damage and the elements.

625.19 Testing of Installations. Furnish equipment and personnel to perform each test as an incidental to the construction of the lighting installation. The Engineer shall witness each test and judge the results.

A. Equipment Calibration. Submit to the Engineer the types, styles, or catalog numbers of all testing equipment to be used for such tests. Include a current Certificate of Calibration for each instrument showing that the instrument is in current calibration using standards traceable to The National Institute of Standards in accordance with the manufacturer's recommended process by a service center authorized by the manufacturer to calibrate the instrument. Certify and demonstrate to the satisfaction of the Engineer that the instrument has remained sealed since the calibration, and that the manufacturer's recommended process for ensuring that the instrument is in working order and producing valid results has been followed in conducting the test.

B. Grounding Electrodes and Grounding Systems. Furnish two certified copies of the completed test records to the Engineer on test reporting forms supplied to the Contractor by the Engineer or on alternate forms approved by the Engineer.

Measure the earth resistance in ohms of each ground immediately after it is installed and before the ground is attached to the item being grounded.

When the ground connection is by driven ground rods, measure each rod separately. In the event that a ground rod has a high resistance and additional rods are being added, measure the earth resistance of the combined group.

Measure a structure grounding system at each point where an exposed metallic item is to be connected to the system. Where driven ground rods are used as the electrodes of the structure grounding system, measure each ground rod separately prior to measuring the system.

Measure each ground grid at the each point where equipment is to be connected to the grid.

C. Circuit Continuity. Upon completion of each lighting circuit but prior to energizing the circuit, verify the continuity of each conductor of the lighting circuit from the power service to the load side socket in the line side of the quick disconnect connector kit in the base of each light pole and the line side of each disconnect switch at each light tower, lighted sign and underpass lighting system shall be verified. Demonstrate that there is no cross connection between the conductor being tested and any other conductor (including conductors for other circuits) or earth ground. Conduct this test by applying a low test voltage between the conductor under test and one of the companion conductors for the same circuit and demonstrating that the test voltage is available between only those two conductors at the power service; the load side socket in the line side of the quick disconnect connector kit in base of each light pole; and the line side of each disconnect switch for a light tower, a lighted sign or an underpass lighting system and repeating the process until all possible pairs have been so checked. Throughout this test, ensure that each disconnect switch is in the open position and that the load side of each connector kit is unplugged. Temporarily disconnect the grounded neutral conductor from earth ground and check all pairings involving the neutral after which again connect the neutral to earth ground and check all pairings, both those involving the neutral and those that do not.

D. Cable Insulation. After the continuity of a conductor has been verified, test the insulation of that conductor and its connections. Ensure that each disconnect switch is in the open position and that the load side of each quick disconnect connector kit is unplugged during this test. Temporarily disconnect a grounded neutral conductor from earth ground when it is being tested. In addition, when a grounded neutral is under test and the circuit utilizes local equipment earthing rather than a continuous equipment grounding back to the power service, temporarily connect one of the companion line conductors to provide the equivalent of the continuous equipment grounding cable.

When the circuit conductor is comprised of both new wire or cable and wire or cable installed prior to the current project, test the insulation by the megohmmeter method and the resistance of the conductor under test to earth ground or any other conductor shall exceed 10 megohms.

When the circuit conductor is comprised of entirely new wire or cable, test the insulation by the high potential method in accordance with Supplement 1003.

E. Lowering Device Operation. Demonstrate to the Engineer that lowering devices on any luminaire supports so equipped operate properly by lowering and raising the luminaire assembly through the full range of motion of the device for each device on two separate occasions at least 10 days apart. The Engineer shall record the dates of operation for each device and in case of failure the details of both the failure and the date and details of the correction. The Engineer will consider a particular unit satisfactory when the device has operated twice in succession on separate occasions without malfunction.

F. System Performance. Prior to acceptance and after all other tests are done, the completed lighting system shall be operated on electrical energy from the power company through the permanent customer service connection in its intended normal manner for ninety consecutive days. Notify the Engineer at least 3 days prior to the commencement of this performance test. In addition to the beginning and ending dates of the test period, the Engineer shall record the date and details of each failure and the date and details of the repair. The Engineer will consider the performance satisfactory when the lighting installation has operated for ninety consecutive days without a failure due to the workmanship of the Contractor.

625.20 Underground Warning / Marking Tape. Install tape approximately 6 to 10 inches (150 to 250 mm) below the final finished grade. Place with the printed side up and parallel with the finished surface. Ensure that the tape is not pulled, distorted, or otherwise misplaced in completing the trench backfill.

625.21 Removal of Lighting Equipment.

A. Luminaire Removal. Remove the luminaire from its support taking care not to damage the luminaire, support or wiring connections. If the luminaire is to be reused within the same project, carefully store the luminaire on the project site. If the luminaire is to be reused, but not within the same project, carefully store the luminaire on the project site for pick up by the owner. If the luminaire is not to be reused, properly dispose of the luminaire off the project site.

B. Luminaire Support Removal. Remove the luminaire support taking care not to damage the luminaire support, foundation or structure to which it is attached or wiring connections. If the luminaire support is to be reused within the same project, carefully store the luminaire support on the project site. If the luminaire support is to be reused, but not within the same project, carefully store the luminaire support on the project site for pick up by the owner. If the luminaire support is not to be reused, properly dispose of the luminaire support off the project site.

C. Luminaire Support Foundation Removal. Remove the luminaire support foundation a minimum of one foot (0.3 m) below finished grade or clear of proposed construction, backfill the resultant depression with compacted soil and restore the disturbed area.

D. Pull Box Removal. Remove the pull box, properly dispose of it off the project site, backfill the resultant depression and restore the disturbed area.

E. Disconnect Existing Circuit. Disconnect the portion of the lighting circuit to be removed or abandoned from the portion of the circuit to remain in service at the designated node point. Remove the cable from the link no longer to remain in service from the node point enclosure. Remove the conduit or duct for the link no longer in service from the node point enclosure and properly close the resultant openings in the enclosure unless the conduit or duct is to be left in place to allow another circuit link to enter the node enclosure.

F. Power Service Removal. Remove the existing power service equipment and properly dispose of the equipment off the project site. Equipment to be removed includes the wood pole or other supporting structure, foundation work pads, equipment enclosures, photoelectric cell and associated conduits, wiring, overhead or underground service lateral and all other appurtenances. Cut the cable enclosed in conduit which runs into the ground at the lower end of the bend to horizontal approximately 2 feet (0.6 m) below grade. Backfill the resultant depression and restore the disturbed area.

Coordinate with the power company to insure that the company disconnects the service and that items which belong to the power company that are removed, such as the meter base, are returned to the power company.

625.22 Method of Measurement. Bracket arms will be included with the light pole, light tower or combination support on which they are mounted for payment. However, when a bracket arm is to be mounted onto an existing support or a support provided by another aspect of the project, it may be a separate item for the purpose of payment in which case payment will be made for each bracket arm.

Transformer bases will be included with the light pole, light tower or combination support on which they are mounted for payment. However, when a transformer base is to be fitted to an existing light pole, it may be a separate item for the purpose of payment in which case payment will be made for each transformer base.

Light pole anchor bolts will be furnished with the light pole and the setting of the anchor bolts included with the foundation. However, in the case of a light pole mounted onto structures such as bridges and retaining walls where the bolts normally furnished with the light pole are not of the proper length and shape and/or the setting of the bolts must be done when the structure is constructed rather than

being at the time of construction of the light pole foundation, the bolts shall be a separate item for payment in which case payment will be for each bolt with the count being the number of bolt ends projecting for the anchoring of the light pole. Separate payment shall also be made when the bolts are being set in a normal light pole or light tower foundation but the light pole or light tower is not being furnished by the Contractor or by others to the Contractor.

Foundations for light poles or light towers include excavation, dewatering, sleeving, casing, reinforcing steel, raceways, concrete, backfilling, and when required the 8 foot or 10 foot foundation section of concrete barrier, and the disposal of surplus excavation. For light poles or light towers mounted on median barrier or retaining walls, the junction box at the point where the stub conduit to the light pole or tower joins the main lighting circuit raceway and the stub conduit from the junction box to the light pole or light tower are also included. Anchor bolts, conduit ells and surface restoration not included elsewhere are also included with the foundation. Junction boxes include the drain.

Pull boxes include the aggregate for base.

Power service includes the control equipment, the support and foundations on which the equipment is mounted, the pull boxes with underdrain for gathering the lighting circuits into the control equipment at the power service location, ground rods and incidentals required for a completed power service. Also included are any poles, conduits, wire and cable to be provided by the owner to receive the incoming power from the power company.

Structure grounding system includes any ground rods or ground grids required as part of the system.

Ground grids include any ground rods required as part of the grid and includes the associated grounding conductor and connections from the resultant grid to the first point (or points) of connection. Ground grids that result from the addition of ground rods as a result of earth ground resistance measurements will be the sum of each ground rod installed such sum will also include all connecting cable and trenching.

A ground rod includes the associated grounding conductor and connections from the rod to the first point of connection.

Trench will be measured to the center of a light pole foundation, the center of a light tower foundation, the center of a pull box, the center of the pole of an embedded pole mounted power service, the center of the foundation for a power service with a foundation, or the wall of the building when the power service for the lighting in, on or within the building with no allowance for elevation change. The payment for trench includes all excavation, granular and other backfill material, compaction, disposal of surplus materials and restoration to match surrounding surface including any seeding, sodding or other plantings which were disturbed and the replacement of any minor items such as guardrail or fence panels, and return to former position and mounting of items such as trash containers, planter boxes or parking meters and small signs which were temporarily moved to facilitate the trenching. The payment for trench in paved areas includes the aforementioned and in addition sawing and removal of pavement, along with the repaving over the trench.

Conduit will be measured to the center of a light pole foundation, the center of a light tower foundation, the center of a pull box, the center of the pole of an embedded pole mounted power service, the center of the foundation for a power service with a foundation, or the wall of the building when the power service for the lighting in, on or within the building with no allowance for elevation change. The payment for conduit includes couplings (plain, expansion, and alignment), bends, hubs, bushings, condulets and other such appurtenances but not junction boxes and pull boxes. Conduit to be encased in concrete or installed by jacking or boring will be paid separately from conduit to be traditionally installed. Concrete and other materials for encasement or the jacking or boring are included with such conduit where specified.

Distribution cable will be measured to the center of foundation, pull box, junction box or power service, plus an allowance of 5 feet (1.5 meters) at each pull box and terminating points for slack and connections end except for a power service where the allowance will be 10 feet (3 meters) to allow for slack and connections with the sum multiplied by the number of conductors required.

Pole and bracket cable will be measured as the light pole support height plus the designated arm length with the sum multiplied by the number of conductors required. For twin arm poles the sum shall be increased by the length of the second arm plus the length of the first arm.

Duct cable will be measured to the center of foundation, pull box, junction box or power service, plus an allowance of 5 feet (1.5 meters) on each end except for a power service where the allowance will be 10 feet (3 meters) to allow for slack and connections with no multiplier for the number of conductors. Duct-cable includes the cable(s) and being a factory assembly is differentiated by the number and size of the conductors in each assembly.

Underground warning / marking tape will be measured to the center of a light pole foundation, the center of a light tower foundation, the center of a pull box, the center of the pole of an embedded pole mounted power service, the center of the foundation for a power service with a foundation, or the wall of the building when the power service for the lighting in, on or within the building with no allowance for elevation change.

625.23 Basis of Payment. The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
625	Each	Luminaire, (Functional Type), (Housing Size if Conventional), (Light Distribution), (Lamp Wattage), (Light Source), (Voltage)
625	Each	Glare Shield
625	Each	Light Pole, (Pole Style),(Design Number)
625	Each	Light Tower,(Design Number)
625	Each	Light Pole Anchor Bolts
625	Each	Light Pole Foundation
625	Each	Light Tower Foundation
625	Each	Junction Box, (Length × Height × Depth)

625	Each	Pull Box, (Material Type), (Length × Height × Depth)
625	Foot (Meter)	Conduit, (Material Type), (Nominal Diameter)
625	Foot (Meter)	Trench
625	Foot (Meter)	Trench in Paved Area
625	Foot (Meter)	Conduit Jacked or Drilled,(Material Type), (Nominal Diameter)
625	Each	Power Service
625	Each	Ground Rod
625	Each	Ground Grid
625	Each	Structure Grounding System
625	Foot (Meter)	Pole and Bracket Cable, (Size of Conductors in AWG), (Voltage Rating)
625	Foot (Meter)	Distribution Cable, (Size of Conductors in AWG), (Voltage Rating)
625	Foot (Meter)	Duct Cable, (Duct Diameter) with (Number of Conductors), (Size of Conductors in AWG), (Voltage Rating) Conductors
625	Each	Connection
625	Each	Service to Underpass Lighting
625	Each	Portable Winch Drive Power Unit
625	Each	Luminaire Removed
625	Each	Luminaire Support Removed
625	Each	Luminaire Support Foundation Removed
625	Each	Pull Box Removed
625	Each	Disconnect Circuit
625	Each	Power Service Removed
625	Foot (Meter)	Underground Warning / Marking Tape

ITEM 626 BARRIER REFLECTORS

626.01 Description. This work consists of furnishing and installing barrier reflectors on guardrail blockouts, concrete barrier, cable barrier, retaining wall, and bridge parapets.

626.02 Materials. Furnish materials conforming to:

Barrier Reflectors..... 726.01

Conform to the manufacturer's recommendations for corrosion resistant fasteners, brackets, or adhesives.

Use barrier reflectors that are mountable on guardrail blockouts, concrete barriers, cable barrier, retaining walls, and bridge parapets. For wall or parapet mount, the barrier reflector may not extend further than 5 inches (125 mm) in a horizontal direction towards the traffic lanes.

626.03 Layout. Lay out all locations to ensure proper placement. The Engineer will approve the layout before installation of the reflectors.

Furnish reflectors at the beginning and the end of all barrier runs and at least one additional point evenly spaced between the termini. Space the reflectors at 100 feet (30 m) on tangents and on curves of less than 5 degrees (more than 350 m radius). Space the reflectors at 50 feet (15 m) for curves of greater than 5 degrees (350 m radius or less).

The Contractor may vary the spacing on tangents and curves of less than 5 degrees (more than 350 m radius) from 65 feet to 125 feet (20 m to 40 m) in the final 250 feet (80 m) to achieve even spacing of the reflectors.

If using a buffer end section or similar device on the end of the guardrail, place the first reflector so that it is visible to approaching traffic.

If tying guardrails, barriers, retaining walls, or bridge parapets together in a continuous run, use the total length of the run for determining the number and location of reflectors.

If installing a run of rail or barrier that is at varying distances from the edge of pavement, place a reflector where the run first approaches closest to the pavement. If this results in spacing greater than 125 feet (40 m), or 65 feet (20 m) in cases where 50 foot (15 m) standard spacing is required, install an additional reflector. If a non-reflectorized impact attenuator is in place, place an additional reflector on the face of the attenuator nearest to, and directed toward, approaching traffic.

626.04 Installation. Attach the reflector with a suitable corrosion resistant fastener or adhesive conforming to the manufacturer's recommendations.

On concrete barriers, retaining walls, and bridge parapets, place the top of the reflector so its height is 26 inches (650 mm) above the near edge of pavement, except that the top of the reflector is at least 3 inches (75 mm) below the top of the concrete barrier.

Install guardrail blockout reflectors on top of the blockout or on the side of the blockout away from traffic. Install guardrail blockout reflectors on the top or side of the blockout nearest the edge of pavement. Install the guardrail blockout reflector so that the reflective surface is above the guardrail.

For guardrail blockout reflectors that are installed on top of the blockout, angle the reflective face approximately 5 degrees towards the nearest travel lane.

Install reflectors that attach to the cable barrier on the cable that is nearest to traffic. If more than one cable is nearest to traffic, attach to the highest cable nearest to traffic. Install them centered between posts.

Remove loose concrete, rust, dirt, and other loose material from the surface of the concrete barrier using a wire brush. Remove dust created by wire brushing before

applying adhesive. Apply adhesive to clean and moisture-free surfaces according to the manufacturer's recommendations.

Ensure that the reflector face is clean and free of dust, dirt, adhesive, or any foreign material after installation.

Except if mounted on a guardrail blockout, rotate the reflective face of one-way reflectors upward from the vertical (or plumb) position 2 to 3 degrees to facilitate "rain washing" of the reflector face.

When replacing reflectors on a concrete surface, locate the new reflector approximately 3 inches (75 mm) horizontally in either direction from the old location.

Use barrier reflectors that are the same color as the adjacent edge line.

For all median cable barrier reflectors, use bi-directional reflectors

Use one-way and bi-directional guardrail blockout, concrete barrier, retaining wall, and bridge parapet barrier reflectors according to the following table:

BARRIER REFLECTORS COLOR & DIRECTION	One-Way Reflector		Bi-Directional Reflector	
	Left Edge	Right Edge	Left Edge	Right Edge
Two-Lane, Two-Way	---	---	---	W/W
Interchange Ramp	---	---	Y/R**	W/R
Multilane Undivided	---	---	---	W/W
Multilane Divided with median barrier*	---	W	Y/Y	---
Multilane Divided without median barrier	---	W	---	---

* concrete wall, guardrail or cable rail
** if median concrete wall is present

The Department will classify the reflectors as follows:

Mounting Location	
Concrete barrier, retaining walls, bridge rail or bridge parapets	
Type 1	Barrier Reflector
Guardrail	
Type 2	Corrosion Resistant Metal Guardrail Blockout Reflector
Type 3	Acrylic or Polycarbonate Plastic Guardrail Blockout Reflector
Type 4	Spring Loaded Guardrail Blockout Reflector
Type 5	L-Type Guardrail Blockout Reflector
Cable Barrier	
Type 6	Cable Barrier Reflector

626.05 Method of Measurement. The Department will measure Barrier Reflector by the number of each in place, completed and accepted.

If a bi-directional reflector consists of two one-way reflectors mounted back-to-back, the Department will measure it as one bi-directional reflector.

626.06 Basis of Payment. The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
626	Each	Barrier Reflector, Type ____ , (One-Way or Bi-Directional)

ITEM 630 TRAFFIC SIGNS AND SIGN SUPPORTS

630.01 Description. This work consists of furnishing and installing traffic signs, sign supports, and foundations complete and ready for service. This work also includes necessary excavation and backfill, disposal of discarded materials, and restoration of disturbed facilities and surfaces to a condition equal to that existing before this work started.

630.02 Materials. The acceptance of materials and products is based on Certified Test Data, furnished in triplicate, or on test results of samples according to 106.02, as required by the Laboratory.

Transfer manufacturers' guarantees or warranties on all traffic sign material to the Department or other maintaining agency upon completion and acceptance of the project.

Furnish materials conforming to:

Concrete, Class QC Misc or QC 1 ..... 499, 511
Steel:
Structural steel 711.01
Reinforcing steel 509.02
U-channel posts..... 730.015
Square posts..... 730.016

Wooden Box Beam.....730.017
Tube and pipe..... 730.01
Anchor bolts and nuts..... 730.02
Poles and arms 730.03
Base and arm plates..... 730.04
Handhole covers..... 730.05
Pole caps..... 730.06
Arm caps..... 730.07
Hardware 730.08
Stainless steel..... 730.09
Stainless steel hardware..... 730.10
Messenger wire 732.18

Aluminum:

Sheet and plate 730.11
Extrusions..... 730.12
Tube and pipe..... 730.13
Castings 730.14
Forgings..... 730.15
Welding rods..... 730.16
Hardware 730.17

Other materials:

Decals..... 725.21
Reflective sheeting, Type F..... 730.18
Reflective sheeting, Type G..... 730.19
Reflective sheeting, Type H..... 730.192
Reflective sheeting, Type J 730.193
Nonreflective acrylic opaque sheeting 730.20
Silk screen inks 730.22
Transparent acrylic electronic cuttable films 730.23

630.03 Shop Drawings. Furnish shop drawings according to 625.06. Submit sign support shop drawings that cover all design types such as ground mounted, rigid overhead, span wire mounted, and overpass structure mounted supports. On the drawings, show overall height, sign clearance above foundation, span length, sign locations, sign overall heights and widths, and glare shield height and location, if applicable.

630.04 Sign Fabrication. Sign types include flat sheet, double faced, extrusheet, and temporary overlay. Flat sheet signs consist of one-piece units made of aluminum. Double faced signs consist of flat sheet aluminum or extruded aluminum blanks with legend on both sides. Extrusheet signs consist of a number of horizontal panels assembled to form a complete sign. Temporary overlay signs consist of an aluminum sheet covering portions or entire surfaces of extrusheet signs.

Prior to reflective sheeting application, clean aluminum sign surfaces either by total immersion in a tank containing an alkaline solution of the manufacturer's specification or by steam cleaning with an alkaline solution of the manufacturer's specification, followed by a thorough rinsing with running water. After cleaning, etch the surface with an acid solution, and dry. Do not allow cleaned and etched surfaces to become contaminated by contact with oil or grease. Drill or punch bolt holes to finish size.

Use sign designs according to the OMUTCD and the Sign Designs and Markings Manual. Use the Standard Alphabets for Traffic Control Devices for positive contrast legends on all guide signs. Do not revise overall sign sizes from what is shown in the plans. The edge space between the border and the text may be adjusted from what is normally used to achieve the sign widths shown. For negative contrast legends, use the Standard Alphabets for Traffic Control Devices. Use capital legends and upper/lower case legends in accordance with the Sign Designs and Markings Manual. When either is permitted in the Sign Designs and Markings Manual, use upper/lower case legends.

For flat sheet, double faced mile marker, and double faced street name signs, use Type G, H or J reflective sheeting for background and reflective legends. For extrusheet signs, use Type G reflective sheeting for the background, and use Type J, ASTM D 4956 Type XI reflective sheeting for reflective legends, shields and symbols (including hazardous material plaque, airport symbol, arrows and borders). Apply reflective sheeting to the surface according to the manufacturer's recommendations, with no blisters, wrinkles, tears, or blemishes. Do not use reboundable or damage control sheeting for permanent signs.

For reflective legends on flat sheet, double faced mile marker and double faced street name signs, use reverse silk screen transparent ink, transparent acrylic electronic cuttable film, or direct applied reflective sheeting copy. When using direct applied reflective sheeting copy, apply all legend on a sign with the same rotation angle orientation. For nonreflective legends, use direct silk screen black ink or direct applied nonreflective acrylic opaque black sheeting copy. For double faced mile marker signs, use flat sheet aluminum and apply reflective sheeting and legend to both sides. For double faced street name signs, use extruded aluminum blanks with a minimum thickness of 0.063 inch (1.6 mm) and thicker, stiffened edges, and apply reflective sheeting and legend to both sides.

Extrusheet panels consist of flat sheet aluminum reinforced with aluminum extrusions attached by spot welding. Panels extruded in a single operation may be used in lieu of spot welded panels. Do not use extruded panels and spot welded panels in the same sign. Bolt together the minimum number of full length, sheeted panels to achieve the sign height, using aluminum bolts, washers, lock washers and nuts. For reflective legends, shields and symbols (including hazardous material plaque, airport symbol, arrows and borders) use direct applied reflective sheeting. Apply all reflective legend on a sign with the same rotation angle orientation. For nonreflective legends, use direct applied nonreflective acrylic opaque black sheeting copy.

For temporary overlay signs, use 0.080-inch (2.0 mm) thick flat sheet aluminum, with a maximum panel size of 8 × 4 feet (2.4 × 1.2 m). Apply sheeting and legend as described above for extrusheet signs. Attach temporary overlays to extrusheet signs in the shop or field using aluminum blind rivets at a maximum spacing of 18 inches (0.5 m) on the peripheries of the temporary overlays and 24 inches (0.6 m) within the interior.

Use fluorescent yellow-green reflective sheeting for the following signs and plaques: School (S1-1), School Bus Stop Ahead (S3-1), SCHOOL BUS TURN AHEAD (S3-2), SCHOOL ENTRANCE (S3-H3), SCHOOL (S4-3P), School Speed

Limit Ahead (S4-5, S4-5a), yellow portions of School Speed Limit (S5-H1), Pedestrian Crossing (R1-6, R1-6b, R1-9), Bicycle (W11-1), Pedestrian (W11-2), Handicapped (W11-9), Bicycle/Pedestrian (W11-15), Trail Crossing (W11-15a), Playground (W15-1), and SAFETY ZONE (W15-H2). Fabricate supplemental warning plaques [such as Advisory Speed (W13-1P), SHARE THE ROAD (W16-1P), Distance (W16-2P, W16-2aP, W16-3P, W16-3aP), Supplemental Arrow (W16-5P, W16-6P, W16-7P) and AHEAD (W16-9P)] from fluorescent yellow-green reflective sheeting when used with a sign above.

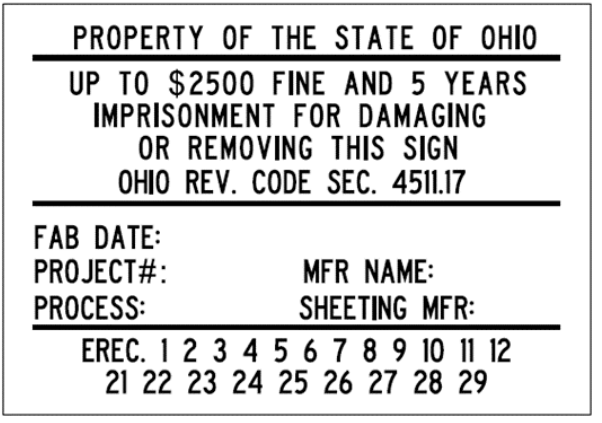
Use fluorescent yellow reflective sheeting for all yellow signs, yellow portions of multi-colored signs, and yellow sign post reflectors, except for signs and portions of signs required to be fabricated with fluorescent yellow-green reflective sheeting.

For lighted signs, cover glare shield and rectangular luminaire support tube with nonreflective acrylic sheeting matching the predominant sign color.

Furnish 4 × 2.5 inch (100 × 62 mm) sign identification stickers of Type F reflective sheeting as shown in Figure 1. For signs fabricated in English based sizes, use white stickers with red ink legend. For signs fabricated in hard metric based sizes, regardless of the sign message units contained on the sign face, use yellow stickers with red ink legend. Place the stickers on the back side of the sign in the lower right corner of rectangular signs, or in an equivalent location for other sign shapes, approximately 3 inches (75 mm) from side and bottom sign edges (for smaller signs, these dimensions may be reduced). Position the sticker so it can be read horizontally and is clearly visible, not near bolt holes or rivets, and not obstructed by the sign support when erected.

Silk screen or digitally print the fabrication data onto the face of the sticker, and include the month and year of fabrication, state project number, sign manufacturer name, the sign process (silkscreen, digital, cut vinyl), and the sheeting manufacturer brand. At the time of sign erection, indicate the erection data by scratching out the appropriate month and year.

FIGURE 1 - STICKER DESIGN



Fabricate sign post reflectors with flat sheet aluminum and match the reflective sheeting type to the sheeting type used for the corresponding sign. Install red sign post reflectors on each post with the following post-mounted signs: Stop (R1-1), Yield (R1-2), Do Not Enter (R5-1), and Wrong Way (R5-1a). Install yellow sign post reflectors on each post with the following post-mounted signs: One-Direction Large Arrow (W1-6), Two-Direction Large Arrow (W1-7), Chevron Alignment (W1-8), and Stop Ahead (W3-1).

630.05 Foundations. Locate sign support foundations so the plane of the sign surface is at a right angle to the roadway lanes served (except for signs not intended for this orientation). Install foundations in accordance with 632.14. Furnish and install a ground rod at each rigid overhead and span wire sign support foundation, in accordance with 625.16.

Before placing foundation concrete for embedded supports, brace the supports in a vertical position. Seven days after concrete placement, remove bracing for embedded supports and erect signs.

630.06 Sign Supports. Sign supports consist of ground mounted, rigid overhead, span wire, and overpass structure mounted types. Fabricate sign supports according to the applicable requirements of AWS D1.1 Structural Welding Code-Steel. The approval of fabricators according to 501.03 will not apply. Hot-dip galvanize steel structural members according to 711.02. Galvanize steel hardware according to 730.08.

Tighten threaded fasteners, except anchor bolt nuts, by the “turn of the nut” method according to 513.20.

Furnish anchor bolts with a leveling nut, plain washer, and anchor nut conforming to 730.02. Use anchor nuts with a plain washer against the base plate upper surface.

Tighten anchor bolt nuts according to 513.20, except that under Table 513.20-3, use the “nut rotation from snug tight condition” from 1/12 to 1/6 turn instead of 1/3 turn.

Apply anaerobic adhesive complying with Federal Standard MIL S 46163, Type II, Grade N to anchor bolts and other threaded connections 1/2-inch (13 mm) diameter or larger, according to the manufacturer’s recommendations.

A. Ground Mounted Supports. Ground mounted supports consist of structural sections of the material and weights required. Drive the ground mounted supports into the earth or embed them in concrete, as specified. Install supports in exposed locations in accordance with the performance requirements of NCHRP 350. The support lengths shown on the plans are approximate. Determine the exact length of supports before fabrication.

1. Post Supports. Mark each driven post with a line of paint 6 inches (150 mm) above the specified driving depth. Drive posts to the specified depth without bending, distortion, or end mutilation. Do not splice posts.

Do not place posts in drainage ditches. If unable to install the post at the specified location, relocate the post with the Engineer’s approval.

Install posts located in paved areas through a hole provided by sleeving or core drilling. After the post is in position, patch the hole with asphalt concrete or an approved asphalt material.

For groupings of flat sheet signs in multiple arrangements mounted on posts, provide sign backing assemblies.

For one-way and street name sign supports, use square posts for mounting signs at right angles to other signs on the post.

For temporary sign supports and their placement, conform to the OMUTCD.

2. Structural Beam Supports. Furnish ground mounted structural beam supports from rolled steel sections. Furnish slip base connections when specified. Bolt the pieces of each beam together, and preload the assembly bolts before delivery to the project. Carefully handle assembled breakaway beams during transportation and erection. Upon erection, perform the final specified torquing on all threaded fasteners.

At least 4 weeks after erecting signs on breakaway beams, inspect the breakaway feature for evidence of shifting or loose fasteners. Re-torque all loose fasteners to specified values. Loosen and re-torque slip base plate fasteners even if no shifting or looseness is detected. Apply anaerobic adhesive to the re-torqued nuts.

3. Pipe Supports. Furnish ground mounted pipe supports from structural steel pipe and tubing. Furnish bolt down anchor installations in existing concrete. Furnish triangular slip base connection when specified.

4. Wooden Box Beam Supports. Furnish wooden box beam supports from laminated veneers pressure treated with wood preservative. Install breakaway feature after installation for supports in exposed locations.

B. Rigid Overhead Supports. Rigid overhead supports consist of single poles with cantilevered arms, or span types supported between end frames. Furnish anchor bolts and conduit ells [at least one 2-inch (50 mm) minimum diameter] for installation in the foundation. Upon erection, set support poles and end frames on their foundations, and plumb using the leveling nuts followed by secure tightening of all leveling and anchor nuts on the anchor bolts. Plumb poles supporting cantilevered signs following erection of signs as required. Ensure that a minimum of one full thread remains on each anchor bolt above the top of the anchor nut after final tightening. Do not use concrete grouting in the space between the foundation surface and support base.

Do not provide cover bases or individual anchor bolt covers on support anchor bases regardless of support location.

Furnish overhead sign supports with sign attachment assemblies for attaching extrusheet signs and/or sign hanger assemblies for mounting flat sheet signs to the support chords.

When specified, furnish sign support identification stickers of Type F reflective sheeting listing the support type, design number, span/arm length, county, route, and section number (example: TC-15.116, design 1, 80 ft span, CUY-90-17.58). Apply stickers only when the ambient temperature is above 40 °F (4 °C).

Locate the sticker approximately 8 feet (2.4 m) above groundline on the quadrant of the sign support facing approaching traffic. Identify sign supports spanning opposing directions of traffic with two stickers, each on a support member facing traffic.

Rigid span supports consist of a box truss supported by single plane truss end frames. Fabricate box trusses from steel tubular members with built-in camber and mark each section "TOP". Do not erect box trusses unless at least one sign or damping device approved by the Engineer is installed within 8 hours. Provide for the attachment of a luminaire bracket arm on combination overhead sign supports.

C. Span Wire Supports. Furnish span wire sign supports with sign hanger and messenger wire assemblies. Furnish anchor bolts and conduit ells [at least one 2-inch (50 mm) minimum diameter] for installation in the foundation.

Achieve a span wire sag under load of 4 to 5 percent of the span. Adjust poles to be essentially vertical after span wire tensioning. Securely tighten all leveling and anchor nuts on the anchor bolts. Ensure that a minimum of one full thread remains on each anchor bolt above the top of the anchor nut after final tightening.

Do not provide cover bases or individual anchor base covers on support anchor bases regardless of support location.

When specified, furnish sign support identification stickers as described in 630.06.B.

D. Overpass Structure Mounted Supports. Mount the supports on the overpass structure so the bottom of the signs are in a level position, regardless of bridge slope.

E. Sign Attachments. Use sign attachment assemblies to attach extrusheet signs to rigid overhead supports. Use sign hanger assemblies to attach flat sheet signs to span wire or rigid overhead supports. Use sign support assemblies to attach flat sheet or extrusheet signs to poles or bridge parapets. Use sign backing assemblies for groups of signs attached to a sign post, and to attach exit number or supplemental panels to an extrusheet sign.

630.07 Sign Erection. Erect signs on ground mounted or overhead supports according to the schematic signing layout. Mount overhead signs so that the bottom of the signs are in a level position regardless of the sag of supporting messenger wire, mast arm rise, chord member or overpass slope. Do not remove an existing sign until the replacement sign is either erected or available for immediate erection. Do not erect a replacement sign on a new support more than 24 hours before the removal of the existing sign.

A. Flat Sheet Sign Erection.

Use steel bolts, wide washers, lock washers and nuts. Use bearing plates between the sign and U-channel post at each bolt. Field drill signs mounted on messenger wire or mast arms to match holes in brackets.

B. Extrusheet Sign Erection.

Use self-aligning aluminum mounting clips, stainless steel T-bolts, stainless steel washers, and stainless steel nylon insert lock nuts, to attach extrusheet signs to sign attachment assemblies, beam or U-channel post supports, and for U-channel

post sections used to attach exit number and supplemental panels to extrusheet signs. Use aluminum bolts, washers, lock washers, and nuts to assemble extrusheet signs shipped in two pieces. Tighten nuts and lock nuts using hand tools only. Do not use pneumatic, hydraulic, battery, electric or other power-assisted tools.

630.08 Sign Shipment and Storage. Package and ship finished flat sheet signs to assure adequate protection of the sign face, using methods and materials as recommended by the reflective sheeting manufacturer.

Ship extrusheet signs up to 8 feet (2.4 m) high completely assembled. Extrusheet signs over 8 feet (2.4 m) high may be shipped in two pieces for field assembly. Keep extrusheet signs rigid by back bracing or crating.

Store signs, whether provided by the Contractor or furnished by the Department, off the ground in a vertical position with adequate covering or shelter to prevent packing material from getting wet. Immediately remove packing material that does become wet from contact with sign faces to prevent damage to the reflective sheeting.

Identify extrusheet signs on a detachable form on the sign back giving the project number and year, sign reference number, sign legend sketch, and station location. Identify the underlying sign for signs shipped with an attached temporary overlay sign.

630.09 Specific Service and Tourist-Oriented Directional Signs. Maintain existing Specific Service (logo) signs, Tourist-Oriented Directional Signs (TODS), and Sponsor-A-Highway signs in accordance with 614.07 unless indicated in the plans.**630.10 Covering of Signs.** Install temporary covers, and subsequently remove and dispose of them as shown on the plans or as directed by the Engineer. For the covering material, use a sturdy opaque material and obtain the Engineer's approval of the proposed method of covering and attachment.

630.12 Removal and Delivery, Storage, Reerection, or Disposal of Signs and Supports. Carefully dismantle signs and sign supports indicated for removal. Either deliver to the Department facility as designated by the plan , store on the project, re-erect, or dispose of removed signs and sign supports. To ensure maintenance of adequate traffic control at all times, remove signs only with the Engineer's approval.

Remove sign supports in a manner to avoid damage. Remove sign service to the support by disconnecting and removing cables at the service pull-box. Ensure that connection of remaining cables conforms to 625.18. Remove support foundations to at least 1 foot (0.3 m) below subgrade or finished groundline. Backfill and restore surfaces to a condition equal to that existing before the work started and dispose of surplus material according to 105.16, 105.17 and 611.15 at no cost to the Department.

Furnish mounting hardware for signs to be re-erected. Field drill as necessary. Furnish anchor bolts and conduit ells for installation in the foundation for overhead sign supports to be re-erected.

Remove temporary overlay signs so as not to damage the underlying sign.

630.13 Inspection. After erection, the Engineer will inspect signs under both day and night conditions. Correct deficiencies in lateral position or visibility to the Engineer's satisfaction.

630.14 Method of Measurement. The Department will measure Ground Mounted Post Support by the number of feet (meters) measured from the bottom of the support to the top of the support, and will include driving, hardware for anchor base installation, and furnishing and placing of patching materials for excavations in paved areas. The Department will not measure the overlap length of post for the anchor base installation.

The Department will measure Foundations for ground mounted pipe supports, ground mounted structural beam supports, rigid overhead sign supports and span wire sign supports by the number of each for one pipe, structural beam, pole, end frame or strain pole, and will include excavation, dewatering, sleeving, casing, reinforcing steel, concrete, backfilling raceways, and when required the 10 foot (3m) foundation section of concrete barrier, and the disposal of surplus excavation. Sealing of the 10 foot foundation section of concrete barrier shall be paid for under Item 512 when specified in the plans.

The Department will measure Ground Mounted Structural Beam Support by the number of feet (meters) measured from the bottom of the foundation to the top of the sign, and will include furnishing and placing of patching materials for excavations in paved areas.

The Department will measure Ground Mounted Pipe Support by the number of feet (meters) measured from the bottom of the foundation to the top of the sign and will include u-bracket, tubing, posts and hardware for sign attachment, bolt-down anchor and furnishing and placing of patching materials for excavations in paved areas.

The Department will measure Ground Mounted Wooden Box Beam Support by the number of feet (meters), and will include excavation, backfilling, disposal of surplus material, and installation of breakaway feature.

The Department will measure One Way Support and Street Name Sign Support by the number of feet (meters) measured from the bottom of the support to the top of the support, and will include driving, hardware for anchor base installation, and furnishing and placing of patching materials for excavations in paved areas. The Department will not measure the overlap length of post for the anchor base installation.

The Department will measure Temporary Sign Support by the number of feet (meters) or the number of each furnished, erected, maintained, and removed.

The Department will measure Breakaway Structural Beam Connection by the number of each set of connection parts with necessary welding and drilling of holes as required for the breakaway function in one beam, and will include base plates, fuse plate, hinge plate, bolt retainer plate, and bolts assembled to specified torques.

The Department will measure Triangular Slip Base Connection by the number of each set of connection parts with the necessary welding and drilling of holes as required for the breakaway function in one pipe and will include slip plate, slip base

casting, locking collar, bolt retainer plate, coiled pin and bolts assembled to specified torques.

The Department will measure Overhead Sign Support by the number of each, and will include anchor bolts and conduit ells furnished for the foundation, sign attachment assemblies, sign hanger assemblies and identification stickers when specified.

The Department will measure Combination Overhead Sign Support with light pole extension by the number of each, and will include anchor bolts and conduit ells furnished for the foundation, sign attachment assemblies, sign hanger assemblies and identification stickers when specified. Bracket arms and roadway lighting luminaires are not included.

The Department will measure Sign Attachment Assembly by the number of separately itemized assemblies, and will include one overhead sign bracket, U-bolts, clamps, and miscellaneous hardware.

The Department will measure Luminaire Support Assembly by the number of separately itemized assemblies, and will include one support arm, other necessary structural members, and miscellaneous hardware.

The Department will measure Span Wire Sign Support by the number of each support, and will include two strain poles with span wire clamps and anchor shackles, anchor bolts and conduit ells furnished for foundations, messenger wire, clamps, thimbles, and sign hanger assemblies with hangers, braces, lengths of post, and miscellaneous hardware.

The Department will measure Overpass Structure Mounted Sign Support by the number of each support, and will include attachment work and hardware, to attach one individual sign.

The Department will measure Sign Hanger Assembly by the number of each, and will include all parts necessary to attach one individual sign.

For pole mounted sign supports, the Department will measure Sign Support Assembly by the number of each, and will include brackets, hardware, and posts sufficient to attach each sign or set of signs to an individual pole.

For bridge mounted sign supports, the Department will measure Sign Support Assembly by the number of each, and will include post, hardware, and attachment work.

The Department will measure Sign by the number of square feet (square meters) of signs, and will include the furnishing of identification stickers, sign backing assemblies, mounting bolts, washers, nuts, bearing plates, clips, and rivets. For square, rectangular, circular, or irregular shaped signs, the Department will determine measurement by multiplying the largest dimensions of width and height. For triangular shaped signs, the Department will determine measurement by multiplying the largest dimension of width and one-half the largest dimension of height. The Department will include the area of the glare shields for lighted signs as an integral part of the sign.

The Department will measure Sign Post Reflector by the number of each, and will include the furnishing of mounting bolts, washers and nuts.

The Department will measure Sign, Double-Faced by the number of each, and will include mounting fittings and hardware.

The Department will measure Sign Erected by the number of square feet (square meters) of signs erected, and will include mounting hardware, the assembly of signs that are in more than one piece and the installation of required sign backing assemblies. The Department will exclude the furnishing of signs. For square, rectangular, circular, or irregular shaped signs, the Department will determine measurement by multiplying the largest dimensions of width and height. For triangular shaped signs, the Department will determine measurement by multiplying the largest dimension of width and one-half the largest dimension of height. The Department will include the area of the glare shields for lighted signs as an integral part of the sign.

The Department will measure Sign Backing Assembly by the number of separately itemized assemblies, and will include back bracing for each group of flat sheet signs attached to a post or posts, or a single assembly for backing posts used to attach an exit or supplemental panel to a guide sign.

The Department will measure Covering of Sign by the number of square feet (square meters) of sign face covered, and will include the subsequent removal and disposal of the covering.

The Department will measure Removal and Delivery, Storage, Reerection, or Disposal of Sign by the number of each sign removed and delivered, stored, re-erected or disposed of. Major signs are defined for measurement as being 40 square feet (3.7 m²) or larger.

The Department will measure Removal and Delivery, Storage, Reerection, or Disposal of Support by the number of each support removed and delivered, stored, re-erected or disposed of, and will include removal of foundations and restoration of surfaces. With reerection, the Department will include furnishing of anchor bolts, conduit ells, necessary field drilling, and hardware.

630.15 Basis of Payment. The Department will not pay for relocating posts from their planned location without prior approval by the engineer.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
630	Each	Ground Mounted Structural Beam Support Foundation
630	Each	Ground Mounted Pipe Support Foundation
630	Each	Rigid Overhead Sign Support Foundation
630	Each	Span Wire Sign Support Foundation
630	Foot (Meter)	Ground Mounted Support, ___ Post
630	Foot (Meter)	Ground Mounted Structural Beam Support, ___ Beam
630	Foot (Meter)	Ground Mounted Support, Pipe
630	Foot (Meter)	Ground Mounted Wooden Box Beam

		Support,_____Beam
630	Foot (Meter)	One-Way Support, ___ Post
630	Foot (Meter)	Street Name Sign Support, ___ Post
630	Foot (Meter) or Each	Temporary Sign Support, ___ Post
630	Each	Breakaway Structural Beam Connection
630	Each	Triangular Slip Base Connection
630	Each	Overhead Sign Support, Type TC-___, Design___
630	Each	Combination Overhead Sign Support, Type TC-___, Design___
630	Each	Sign Attachment Assembly
630	Each	Luminaire Support Assembly
630	Each	Span Wire Sign Support, Type TC-17.11, Design ___
630	Each	Overpass Structure Mounted Sign Support, Type TC-___, Design___
630	Each	Sign Hanger Assembly, (Span Wire, Mast Arm)
630	Each	Sign Support Assembly, (Pole or Bridge Mounted)
630	Square Foot (Square Meter)	Sign, (Flat Sheet, Ground Mounted Extrusheet, Overhead Extrusheet, Temporary Overlay)
630	Each	Sign, Double-Faced, (Street Name, Mile Marker)
630	Square Foot (Square Meter)	Sign Erected, (Flat Sheet, Extrusheet, Temporary Overlay)
630	Each	Sign Backing Assembly
630	Each	Sign Post Reflector
630	Square Foot (Square Meter)	Covering of Sign
630	Each	Removal of Ground Mounted (Major) Sign and (Delivery, Storage, Reerection, or Disposal)
630	Each	Removal of Ground Mounted (Structural Beam, Post, Pipe, Wooden Box Beam) Support and (Delivery, Storage or Disposal)
630	Each	Removal of Overhead Mounted Sign and (Delivery, Storage, Reerection, or Disposal)
630	Each	Removal of Overhead Sign Support and (Delivery, Storage, Reerection, or Disposal), Type TC-___
630	Each	Removal of Overlay Sign

ITEM 631 SIGN LIGHTING AND ELECTRICAL SIGNS

631.01 Description

631.02 General

631.01 Description. This work consists of furnishing and installing sign lighting or electrical sign equipment, complete, tested, and ready for service.

631.02 General. Perform installations according to the National Electrical Safety Code, the National Electrical Code and local codes for the area of installation. Furnish overhead sign lighting and integrate electric power with roadway lighting circuits.

Furnish shop drawings according to 625.06.

Conform to the requirements of Supplement 1063 for the installation or testing of electrical items installed under 631.08 and 631.09.

Protect wire and cable by installing entirely within support structure interiors, enclosures, junction boxes, and rigid or flexible conduit. Ensure that the methods, materials, and locations of splicing and the methods of connecting and identifying wire and cable conform to 625, 725, and the plans. Furnish grounding systems according to 625.16.

Power service is furnished under 625.

631.03 Materials and Equipment. Furnish materials and equipment that are new, of first quality, of current design, and free from defects.

Use electrical parts, wire, switches, and other elements of the installations that are of ample capacity to carry the required current without excessive heating or drop of potential.

Ensure that each item of equipment bears a nameplate, indelible marking, or brand that identifies the type, model, catalog number, and manufacturer.

Furnish materials conforming to the following:

Ground rod	625.16
Sealing, conduit	625.12
Cable and wire, 600-volt	725.02
Conduit, rigid	725.04
Ballast	725.11
Power service	725.19
Disconnect Switch	725.19
Switch Enclosure	725.19
Changeable message sign, electric type	731.03
Internally illuminated fixed message sign	731.05

631.04 Sign Service. Sign service consists of all cable and other equipment to provide a complete electrical service from either an underground or overhead source to the disconnect switch.

Route sign service cable from a pull box to the switch enclosure for overhead supported signs by means of underground conduit, foundation conduit ell, and the interior of the structural member supporting the enclosure.

Route sign service for overpass structure mounted signs through underground and structure attached conduit terminating at a switch enclosure. Attach the conduit by 0.02-inch (0.5 mm) thick by 3/4-inch (19 mm) wide passivated stainless steel straps spaced at intervals of not more than 5 feet (1.5 m).

Route sign service cable from a distribution system direct drop to the switch enclosure by means of a conduit riser with weatherhead. Form a drip loop into the cable. Use either a cast aluminum or galvanized ferrous metal weatherhead of a threaded design. Attach the conduit by straps as described in the previous paragraph.

For sign service, use single conductor stranded copper. When the connection is to highway lighting distribution and circuit cable, use the same cable for sign service. In other applications, use sign service cable rated at 600 volts minimum and not smaller than 4 AWG.

631.05 Signs Wired. Ensure that signs wired complete the electrical system from the disconnect switch to the luminaires.

Furnish continuous wiring from the disconnect switch to a junction box mounted on the sign support or overpass structure. Install junction box in a manner that allows sign removal as a unit by the disconnection of the wires and the removal of sign attachment hardware. Install a junction box for each sign.

Furnish continuous wiring from the junction box to the first luminaire and between additional luminaires.

Use wire rated at 600 volts, single conductor and not smaller than 10 AWG.

Route wire on overhead sign supports from the disconnect switch enclosure through structural member interiors. Support wire hanging within the interior of steel vertical members by looping over the J-hook provided. After wiring in the disconnect switch enclosure, seal the nipple in the enclosure back with self-fusing high-dielectric insulating compound.

Assemble flexible or rigid conduit on the sign structure or lighting support arms with condulets, and attach them to the structure by clamps located within 6 inches (150 mm) of each conduit end and separated by not more than 24 inches (0.6 m).

631.06 Disconnect Switch. Install lighted signs with a disconnect switch within a lockable, weatherproof enclosure. For the switch, use a two-pole (minimum), single-throw, fused safety disconnect type, rated at 600 volts, 30 amperes with the fuse size as specified. Furnish a solid neutral bar.

For the enclosure, use stainless steel NEMA 250, Type 4. Furnish space for a chase nipple in the enclosure back. Field drill a hole through the enclosure and install the nipple. Ensure that enclosures also have a screened 1/4-inch (6 mm) diameter weep hole located in the bottom surface.

Furnish each enclosure with at least one padlock. Use padlocks with a bronze or brass lock body and a corrosion protected steel shackle. Key all padlocks for a project alike, and obtain the appropriate master key number from the maintaining agency.

When specified, furnish and install bracket assemblies on existing overhead sign supports or on concrete structures. Use bracket assemblies made of steel, galvanized according to 711.02, or aluminum.

631.07 Luminaire. Include a lamp of the wattage specified.

Locate ballasts integral with the luminaire. Furnish weatherproof ballast housings made from corrosion resistant materials.

631.08 Controls. When specified, furnish photoelectric controls when sign lighting is fed by uncontrolled circuits.

When specified, furnish and install the timer with enclosure to provide automatic school speed limit sign operation.

631.09 Electrical Signs. Furnish changeable message signs that conform to the Contract Documents. The pay item will specify if the display capabilities are limited message or unlimited message. The Contractor may use line units of these types as inserts in a panel sign, singly or grouped to provide a multiline sign. Hardware and software shall be complete to operate and maintain the sign.

Furnish internally illuminated signs consisting of the single or double face type. The sign support is furnished under another pay item. Furnish suspended signs that hang plumb, are properly oriented, and locked in place.

Furnish sign flasher assemblies consisting of a pair of flashing beacons. The sign, support, and foundation are furnished under other pay items.

Furnish school speed limit sign assemblies that conform to the Contract Documents. School speed limit sign assemblies consist of a reflectorized SCHOOL SPEED LIMIT 20 DURING RESTRICTED HOURS (S5-H1) sign fitted with a pair of flashing beacons arranged above and below.

631.10 Removal. Carefully remove sign lighting equipment (such as luminaires, disconnect switches, or ballasts) and electrical signs. Removed items become the property of the Contractor.

631.11 Inspection and Testing. Ensure that the sign lighting systems and electrical signs meet all requirements of the ground, cable insulation, and performance tests specified in 625.19. Correct lamps, ballasts, and transformers that failed during the performance test by replacing the faulty component; the entire test period will not require restarting.

During the performance test, make final adjustments to sign lateral position and aiming angles of luminaires to eliminate excessive brightness and glare, and to

obtain optimum sign face reflected brightness, uniformity of illumination, visibility, and legibility, to the satisfaction of the Engineer.

631.12 Method of Measurement. All of the following methods of measurement include all hardware necessary to securely mount the associated item including angles, plates, tubes and channels.

The Department will measure Sign Service by the number of complete units for each support, and will include conduit, conduit riser, weatherhead, fittings, cables, trenching, and backfilling.

The Department will measure Sign Wired and Sign Wired, Overpass Structure by the number of complete units of wiring for each individual sign, and will include junction boxes, rigid or flexible conduit, condulets, clamps, wires, and connectors.

The Department will measure Disconnect Switch with Enclosure by the number of each, and will include field drilling and padlocks.

The Department will measure Switch Enclosure Mounting Bracket Assembly by the number of each, and will include two brackets and field drilling.

The Department will measure Ballast and Photoelectric Control by the number of each separate item.

The Department will measure Luminaire by the number of each, and will include lamps and luminaire attachment hardware.

The Department will measure Changeable Message Sign by the number of each, and will include cabinet, external enclosures, conduit, electrical, electronic and auxiliary components, and remote control units to provide a fully functional unit.

The Department will measure Internally Illuminated Fixed Message Sign by the number of each, and will include lamps and ballasts.

The Department will measure Sign Flasher Assembly by the number of each, and will include beacons, flasher control unit with enclosure, and lamps.

The Department will measure School Speed Limit Sign Assembly by the number of each, and will include sign, beacons, flasher control unit with enclosure, and lamps.

The Department will measure Timer with Enclosure by the number of each, and will include field drilling and padlocks.

The Department will measure Removal of sign lighting equipment or electrical signs by the number of each like items removed.

631.13 Basis of Payment. The Department will pay for grounding systems under Item 625.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
631	Each	Sign Service
631	Each	Sign Wired
631	Each	Sign Wired, Overpass Structure

631	Each	Disconnect Switch with Enclosure, Type ___
631	Each	Switch Enclosure Mounting Bracket Assembly
631	Each	Ballast, Type ___
631	Each	Photoelectric Control
631	Each	Luminaire, Type ___, with ___-watt Lamp
631	Each	Changeable Message Sign, (Limited, Unlimited) Message
631	Each	Internally Illuminated Fixed Message Sign, Type ___
631	Each	Sign Flasher Assembly
631	Each	School Speed Limit Sign Assembly, ___ inches × ___ inches (___ mm × ___ mm)
631	Each	Timer with Enclosure
631	Each	Removal of (Luminaire, Disconnect Switch, Ballast, etc.)

ITEM 632 TRAFFIC SIGNAL EQUIPMENT

632.01 Description. This work consists of furnishing and installing traffic signal equipment, complete and ready for service. This work also includes necessary excavation and backfill, disposal of discarded materials, restoration of disturbed facilities, and surfaces to a condition equal to that existing before the Work started, and electrical testing as specified.

Pull boxes, conduits, ground rods, and cable splicing kits required for traffic signal equipment installations are specified in Item 625.

632.02 Contractor Personnel Requirements. Conform to the requirements of Supplement 1063 for the installation or testing of traffic signal equipment.

632.03 Materials and Equipment. Furnish new materials and equipment of first quality, of current design, and free from defects.

Use electrical parts, wire, switches, and other elements of the installations capable of carrying the required current without excessive heating or drop of potential.

Ensure that major items or assemblies of equipment bear a nameplate, indelible marking, or brand that identifies the type, model, catalog number, and manufacturer.

Furnish materials and equipment conforming to:

Concrete, Class QC Misc or QC 1 ..... 499, 511
Steel*:
Poles, supports, arms, appurtenances and anchor bases ..... 730.02, 730.03, 730.04, ... 730.05, 730.06, 730.07, ... 732.12, 732.11
Pedestals 732.15
Backplates 732.22
Hardware 730.08
Stainless steel hardware 730.10
Other Items:
Conduit, rigid 725.04, 725.051, 725.052
Ground rod 725.16
Pull boxes 725.06, 725.07, 725.08, 725.12
Identifying tags or bands 725.02
Signal heads 732.01, 732.02, 732.03, 732.05
Lamps 732.04
Pushbuttons 732.06
Detectors 732.07
Wood poles 732.13
Down guys 732.14
Conduit risers 732.16
Cable supports 732.17
Messenger wire 732.18
Cable and wire 732.19
Power service 732.20
Disconnect Switch with enclosure 732.21
Backplates 732.22
Tether Wire 732.18

* Acceptance of materials and products is based on certified test data, furnished in triplicate, or on test results of samples according 106.04, as required by the Laboratory.

632.04 Shop Drawings. Furnish shop drawings according to 625.06.

632.05 General. Ensure that major items of traffic signal control equipment used in combination are compatible, interchangeable and, whenever feasible, provided by the same manufacturer or supplier. Perform work in compliance with applicable local laws and codes, the National Electrical Code, the National Electrical Safety Code, the Standard for Electrical Safety in the Workplace and OSHA.

Ensure that the traffic control equipment installed in controller cabinets are shop prewired according to a wiring diagram that conforms to plan and specification requirements of the specific project and intersection, and show all wire harness and field connections required, with abbreviations according to Table 632.05-1. Furnish a neat and legibly drawn wiring diagram, reproduced on durable paper, and place two copies in a plastic envelope fastened to the inside of the controller cabinet.

Identify cable and wire by tags or bands at pull boxes and controller cabinets, with size, material, and method of marking that conform to 725.02, except ensure that the identification on the tags or bands conforms to the wiring diagram with abbreviations according to Table 632.05-1. The Contractor may identify field wiring using an indelible pen on a plastic tag instead of embossed letters. Tags shall be a minimum of 1 inch diameter if round and 1 inch by ½ inch if rectangular. Letters shall be clearly legible.

Use spade terminals for wiring connected at signal heads and the wiring connected at terminal blocks within controller cabinets. However, for incoming power wiring, use either spade terminals or bared conductor wire connected to terminal points utilizing screw or spring applied clamping surfaces compatible with both cooper and aluminum wire and providing a positive grip. Neatly lash and fasten completed wiring to interiors with clamps and/or ties.

TABLE 632.05-1 TABLE AND WIRE IDENTIFICATION

Cable	Tag
Ground	GND
Power (2 wire)1∅ 120 volt	AC +AC- or ACN
Power (3 wire) 1∅ 120/240 volt Neutral wire	AC + 1, AC + 2 AC- or ACN
Phase A Phase 1 Phase 1 northbound left turn lanes	∅ A ∅ 1 ∅ 1 NBLT
Phase A, pedestrian signal	∅ A PD
Radar, Advance Detection Phase, Direction	RAD-Adv ∅2, NB
Radar, Stop Line Detection Phase, Direction	RAD-SL ∅1, SBLT
Overlap, phase A + C Overlap, phase 1 + 6	∅ A + C ∅ 1 + 6
Detector lead-in, phase A Detector lead-in, phase 1 Detector lead-in, phase 1 northbound left turn lanes	DET A DET 1 DET 1 NBLT
Detector lead-in, phase A (call type) Detector lead-in, phase 1 (call type) northbound thru lanes	DET A CALL DET 1 CALL NB-THRU
Detector harness[1]	DET A
Interconnect	IC
Pre-emption, fire	PE FIRE
Pre-emption, railroad	PE RR
[1] Place the tag next to the MS plug at the detector amplifier.	

When constructing the traffic control system, cooperate with the agency supplying the electric service. Supply 120/240 volt, single-phase, three-wire (grounded neutral) power to the disconnect switch.

After completion of the 10 day performance test in compliance with 632.28 and until acceptance, the Contractor is responsible for the care and maintenance of traffic control equipment installed or reused as part of the Contract.

Upon acceptance of the project, transfer to the Department all manufacturers' guarantees or warranties covering installed electrical or mechanical equipment. Furnish two copies of wiring diagrams, service manuals, and instructions on installation and maintenance for each different type, model, or system of equipment used on the project.

632.06 Vehicular Signal Head, Conventional. Furnish heads in arrangements such that from one to a maximum of five sections assembled with the specified lens size, color, and circular or arrow configuration form a specific signal face. Mount signal faces alone as a one-way head when backplates are used.

Install signals in a plumb condition, using a balance adjuster only if approved by the engineer. Rigidly mount heads to mast arms with the yellow module located in front of the mast arm. Use drop pipes/extenders of suitable length only when necessary to bring the bottom of the signal heads to a proper roadway clearance. Drop pipes/extenders shall be kept as short as necessary on backplated signals. Use of drop pipes/extenders greater than 1.5 feet in length must be approved by the Engineer. Use disconnect hangers for suspended heads only when specified.

Orient each signal face to its traffic approach, and lock faces in place by the serrated or other type device incorporated in signal housing and support hardware. Before closing serrations, apply a bead of Room-Temperature Vulcanizing (RTV) silicone to all serrated surfaces and then tighten to achieve positive locking. RTV silicone shall be white to facilitate visual inspection. On heads with dual concentric serrated rings, completely fill the space between the rings with RTV silicone.

For span wire installations, do not use balance adjusters on one-way heads or tethered heads.

Install LED lamps in each section.

Furnish backplates unless specified otherwise.

632.07 Vehicular Signal Head, Optically Programmed. Furnish heads of this type consisting totally of optically programmed sections unless an intermix of optically programmed and conventional sections is specified. Install approved LED light sources or lamps in each optically programmed section.

Program each signal section according to the plan requirements. Upon completion of the project, deliver all programming tools and devices to the maintaining agency.

Furnish backplates unless specified otherwise.

632.08 Pedestrian Signal Head. Furnish heads with the type of light source and symbol height specified. Orient each signal head to its crosswalk, and lock heads in place by the serrated or other type device incorporated in signal housing and support hardware. Close openings unused for mounting purposes with weatherproof caps.

632.09 Pedestrian Pushbutton and Accessible Pedestrian Pushbutton. Properly orient and install pushbuttons on poles or pedestals. Service pushbuttons mounted on steel poles by wiring inside the poles. Furnish 3/4 inch (19 mm) diameter holes through the back of the housing and the pole wall, install a rubber grommet, and route wiring through until no external wiring is visible. Plug any unused conduit attachment holes. Attach the housing by machine or self-tapping screws in the housing back wall. Service pushbutton mounted on wooden poles through conduit. Furnish flat sheet pedestrian pushbutton signs in accordance with 630.04.

632.10 Loop Detector Unit. Install and tune detector units to their loops with the sensitivity set for optimum operation and any interference or cross talk eliminated between other detector units in the cabinet. Perform a field check to ensure that no extraneous detections are occurring by observing each detector unit's operation to determine that a signal occurs only when a vehicle enters its associated loop. If actuations are observed when there is no vehicle in the loop, eliminate the

extraneous detections. For any project using State or Federal funds, all stop line detection zones shall reliably detect motorcycles and bicycles, and all dilemma zone detectors shall reliably detect motorcycles.

632.11 Detector Loop. Saw slots in the pavement for installation of vehicle detector loop wire in the configuration, dimensions, and combinations required. Cut an extension from the loop to the pavement edge to allow wire routing to an adjacent pull box.

Furnish slots 1/16 to 1/8 inch (1.6 to 3 mm) wider than the outside diameter of the loop wire or tubing. Ensure that the slot depth provides a covering of not less than 3/4 inch (19 mm) above the uppermost detector wire tubing after the loop installation is completed. Before installing loop detector wire, brush and blow all slots clean of loose material and completely dry. Install loop detector wire according to 632.23. Conform to all applicable state and local nuisance dust regulations, and OAC 3745-17-08 while saw cutting.

Fill the slots completely with a flexible embedding sealant, listed on the ODOT QPL. Do not disturb slots until sealant has cured. Cured sealant shall be level with or higher than the pavement surface.

For loop detector wire installations in new asphalt, the Contractor may saw slots and embed sealant in a subsurface course with subsequent covering by the surface course, subject to the Engineer's approval.

632.14 Foundations. Locate support foundations, and stake with the proper elevation. If underground or overhead obstacles are encountered during stakeout, or to correct slope and subsurface difficulties, change foundation location and orientation with the approval of the Engineer. Ensure that the approved location provides a safe clearance from overhead power lines for construction operations, in compliance with applicable Codes. The Contractor is responsible for the correct location, elevation, and orientation for all poles and pedestals installed on the foundations.

Excavate for foundations using an earth auger to specified dimensions according to 524. Exercise caution when excavating in areas of underground installations to avoid their disturbance or damage. If subsurface obstructions are encountered, remove the obstructions, or replace the excavated material and relocate the foundation, with the Engineer's approval. If bedrock is encountered, the Contractor may reduce that portion of the specified foundation depth within the bedrock up to 50 percent. Perform all necessary dewatering of the excavation.

Perform foundation concrete work according to 524, except as modified by this subsection. When squared tops are required, as in sidewalks, form the top of the foundations to a nominal depth of 6 inches below the groundline. Place the concrete foundation, including formed top, in one continuous concrete pour.

For foundations for anchor base type supports, provide the required reinforcing rods, and have anchor bolts and conduit ells accurately held by a template.

Remove forms and templates once the concrete has hardened sufficiently so as not to be susceptible to damage. After 14 days, erect and load supports on anchor base foundations. The Contractor may erect and load supports after 7 days if the

tests of two beam specimens of concrete yield an average modulus of rupture of not less than 650 pounds per square inch .

632.15 Signal Support. Furnish supports with mast arms with the required pole and arm length, damping device if arm length requires, anchor bolt circle diameter, and anchor bolt size.

Ensure that the combination signal supports with light pole extension provide for the attachment of a luminaire bracket arm. Adjust anchor base type supports with an initial rake so that when loaded the support poles assume an essentially vertical position.

For support designs not specifically shown on the plans, demonstrate, to the Director's satisfaction, that supports are structurally equivalent to the specified design.

Do not use concrete grouting in the space between the foundation surface and support base.

Conform to the requirements of AASHTO LRFDLTS-1, including all interim releases.

Do not erect signal supports unless at least one signal, sign or damping device approved by the Engineer is installed within 24 hours.

632.16 Strain Pole. Furnish strain poles for the attachment of messenger wire with the required pole length. Use anchor base type strain poles. Adjust anchor base type poles with the initial rake so that when loaded the poles assume an essentially vertical position.

Ensure that the combination strain poles with light pole extension provide for the attachment of a luminaire bracket arm.

Conform to the requirements of 630.06 for threaded fasteners, anchor bolts, anchor bolt nuts, and anaerobic adhesive.

632.17 Wood Pole. Set wood poles in holes excavated by an earth auger to a minimum depth of 6 feet (1.8 m). Use an auger with a diameter approximately 4 inches (100 mm) greater than the pole butt. Hold poles with initial rake, up to a maximum of 12 inches (0.3 m), while tamping backfill into place, so that under messenger wire tensioning conforming to 632.22, the poles assume an essentially vertical position. Furnish backfill material no greater than 1 inch (25 mm) in size, and thoroughly tamp material in lifts not exceeding 6 inches (150 mm), to the satisfaction of the Engineer. If concrete embedment is specified, brace the poles until the concrete has set.

Liberally coat field holes bored for the attachment of messenger or guy wire with approved creosote base paint and fitted with 5/8 inch (16 mm) thimble-eye through-bolts and 3 inch (75 mm) washers. Securely attach and protect ground wire furnished as part of another work item with a wood or plastic molding for a minimum distance of 10 feet (3 m) above groundline.

632.18 Down Guy Assembly. Install and tension guy assemblies before erecting signals such that they will resist the major portion of the horizontal loading caused by loading of the messenger wire.

632.19 Pedestal. Furnish pedestals for the support of traffic control equipment with a cast or plate steel base, unless a transformer type base is specified.

632.20 Conduit Riser. Attach risers to poles to provide a wiring raceway and include a weatherhead, conduit, necessary fittings, and pole attached clamps. Attach risers to poles by clamps spaced at intervals not exceeding 5 feet (1.5 m). Paint conduit risers mounted on painted poles to match the poles.

632.21 Cable Support Assembly. Use cable support assemblies to eliminate strain on cables, or groups of cables up to a maximum of four, entering the interior of poles through a weatherhead or mast arm. If required, include a length of messenger wire forming a sling with ends formed of lapped wire, thimbles, and clamps as part of the assembly.

632.22 Messenger Wire. Arrange messenger wire with accessories between two or more poles to provide support and attachment for traffic control equipment. Accessories used with messenger wire include bullrings, thimbles, preformed guy grip dead ends, and three bolt clamps. Furnish bullrings at messenger wire network corners. Use thimbles to attach messenger wire to the shackles of strain pole clamps and bullrings.

Adjust the length of the messenger wire under the load of traffic control equipment so the sag at the lowest point is not greater than 5 percent or less than 3 percent of the span. Attach signal cable to messenger wire with lengths of preformed helical lashing rod that are of a proper internal diameter to tightly secure the cable to the messenger wire. Attach interconnect cable with preformed lashing rod or spinning wire.

632.225 Tether Wire. Arrange tether wire with accessories to stabilize signal heads and prevent excessive swinging and twisting. Install shim washers on hanger pin adjacent to wire entry to prevent any twisting of the head on the hanger. Accessories included with tether wire shall be those shown in the appropriate Plan Insert Sheet or Standard Construction Drawing and include pole clamps, anchor shackles, S-hooks yielding element, thimbles, turnbuckles, guy grips, wire rope clips, backup ties, lock wire, safety tie wires, and signal head tether anchors and extenders.

Adjust the tether span to be horizontal on simple spans. On all spans, install tether horizontally and tighten with turnbuckles. Bull Rings will be used at all internal corners of the tether span. Safety ties shall be installed at all yielding (S-hook) locations to prevent the span end from dropping into the roadway if the S-hook opens. No electrical or communication cables of any kind shall be attached to the tether wire. No signs or other devices shall be suspended from or attached to the tether wire. Turnbuckles shall be tightened by hand to achieve the tether wire tension shown in appropriate Plan Insert Sheet or Standard Construction Drawing. Measure tether tension with Loos & Co., Inc. Model PT-2 or approved equal. Record tension test results and present written copy to the Engineer.

632.23 Cable and Wire. Fashion cable at traffic signal equipment weatherhead entrance fittings into a drip loop that extends at least 6 inches (150 mm) below the entrance. Do not allow the cable to chafe on the equipment. Support cables installed

in strain poles and signal supports with cable support assemblies according to 632.21.

Do not use splices in any cable or wire, except at the following locations:

A. At the junction of detector wire and lead-in cable.

B. At the junction of power cable and the power supply source or service cable.

C. On long lengths of interconnect or service cable.

For splices allowed in aerial installations, accomplish splicing in weather tight splice enclosures. For splices allowed in underground installations, accomplish splicing in pull boxes or poles where the splice is encapsulated with poured waterproof epoxy insulation according to 725.15.

Install signal cable between signal heads and controller cabinets. Signal cables shall not be stripped beyond a length necessary to attach individual conductors within the signal head . The jacket shall extend into the signal head enclosure. Install interconnect cable between controller cabinets of different intersections. Route signal and interconnect cable by aerial installation supported by messenger wire or within underground conduit. If specified, use aerial self-supporting integral messenger type interconnect cable with a figure "8" cross-section and include pole clamps and splice enclosures. Ground the supporting messenger wire of interconnect cable.

Provide loop detector wire consisting of detector wire inserted into flexible plastic tubing. Use of factory-manufactured preformed loops is permitted. Ensure that the tubing encases the wire continuously from the splice at the lead-in cable, through the entire loop turns, and back to the splice. Install loop detector wire in sawn roadway slots forming loops according to 632.11. Furnish the required number of turns of wire installed for each loop, and push the wire carefully into the slots with a blunt tool to avoid damaging the tubing. Run the wire continuously around the loop perimeter and through a slot leading to the pavement edge and by underground conduit to a roadside pull box or pole with 5 feet (1.5 m) at each end for slack and splice. Uniformly twist wires and tubing installed in the conduit to the splice with lead-in cable at 3 to 5 turns per foot (10 to 16 turns per meter). Splice the loop ends to lead-in cable, which is connected to the controller cabinet. Join the wires by a mutually twisted in-line splice, rosin core soldered, and wrapped in vinyl or equivalent electrical tape, and encapsulate wires with an approved poured waterproof epoxy insulated splice according to 725.15. Extend and seal the tubing ends into the poured epoxy splice. Also, solder crimped terminals to the conductors and the shield for connections inside the cabinet.

Install power cable from the power supply source to the controller cabinet. If multi-conductor power cable is specified, the Contractor may substitute multiple single conductors. This compensation is for invoiced cost without mark-up.

Install service cable aerially from a remote power source to the vicinity of the controller cabinet with the support cable functioning as the electrical neutral. Furnish connections used with aluminum power or service cable of an approved type for aluminum to aluminum or aluminum to copper connections, and insulate connections with an approved vinyl mastic pad.

632.24 Power Service. Furnish and install all equipment necessary to provide complete electrical service to each signal installation as shown on the plans. Make all necessary arrangements with the local electrical power company for connections to establish electrical service. Charges made by the power company for establishing of the account, extension of company facilities, connection of customer equipment to the power company facilities and energy will be borne by the maintaining agency. This compensation is for invoiced cost without mark-up.

Power service consists of equipment to provide a pole attached wiring raceway and disconnect switch for use with power cable routed from the service entrance to the controller cabinet. The power service installation includes a weatherhead, conduit and fittings, a disconnect switch with enclosure, meter base and attachment clamps. It also includes the intersection lighting disconnect and associated equipment when intersection lighting is present.

Bend the conduit away from the pole at the top and bottom of the riser to allow the conduit to enter straight into the enclosure or meter base hub, and to provide space for the weatherhead when the riser is pulled tight against the pole. Furnish watertight conduit connections between the meter base and enclosure by using conduit hubs listed on the enclosure UL label.

Furnish each enclosure with at least one padlock. Use padlocks with a bronze or brass lock body and a corrosion protected steel shackle. Obtain the appropriate master key number from the maintaining agency.

Paint conduit risers mounted on painted poles to match the poles.

632.25 Covering of Vehicular and Pedestrian Signal Heads. Cover vehicular signal heads if erected at intersections where traffic is maintained before energizing the signals. Cover pedestrian signal heads when specified in the plans. Use a sturdy opaque covering material specifically made for use with traffic signals and ensure that the color of the cover is different than the signal head, tan or white, so that it is clear to drivers and pedestrians the heads are covered, not dark. Use a method of covering and cover attachment and materials as approved by the Engineer. Covers are to be free of text, pictures, or any type of advertising. Maintain covers and remove them when directed by the Engineer.

Completely cover the entire signal head, including backplates with reflective borders in such a manner that the reflective borders are not visible.

Do not operate covered signals at night and ensure no conflicting signal light is visible at night. Comprise covers of 16 oz./yd. vinyl-coated polyester fabric consisting of no more than 2 layers sewn together. Completely cover signal, including central slits or ports in the cover, any time no active work is occurring on the signal installation.

632.26 Removal of Traffic Signal Installation. Remove signal heads, cable, messenger wire, strain poles, cabinet, controller, or other incidental items required by the Engineer. Remove support foundations to at least 1 foot (0.3 m) below subgrade or finished groundline. Backfill, restore surfaces, and dispose of surplus material according to 105.16, 105.17 and 611.15. Store removed items on the project for salvage by the maintaining agency, or reuse removed items as part of a new installation on the project under another item of work. Dispose of all items not

designated for salvage or reuse. As specified in 614.03, do not remove signals until a new signal system or a temporary traffic control method approved by the Engineer is in operation. Suitably protect stored equipment.

632.27 Reuse of Traffic Signal Equipment. Reinstall or re-erect specified traffic equipment, removed from existing signal installations within the project. Clean and restore reused equipment to an operating condition. Furnish all additional hardware and incidentals necessary to allow reuse of the equipment.

632.28 Testing.

A. General. Furnish all personnel and equipment required to successfully perform the following tests, and furnish to the Engineer six certified copies of complete test records, test reporting forms supplied by the Engineer, or alternate certification approved by the Engineer.

B. Ground Test. Measure each ground rod for earth resistance according to 625.19, except that measurements are not necessary immediately after installation.

C. Short-Circuit Test. Before performing any cable insulation tests or performance test, perform a short-circuit test with a volt-ohmmeter or other approved instrument. Conduct short-circuit tests with electrical loads, power sources, equipment grounds, and earth grounds disconnected. Test signal cable routed to signal heads with connections made to lamp sockets without lamps installed. Measure each conductor against every other conductor and ground to ensure that no short-circuits, cross-circuits, or other improper connections exist. Ensure that continuity does not exist between any conductor and another conductor including ground.

D. Circuit Continuity Test. Temporarily jumper each circuit branch at its termination and the temporarily looped circuit measured for continuity to ensure that no open circuits exist, that the circuit branch is according to plan, that no high resistance connections exist, and that each circuit is properly identified. Test the lead-in cable for loop detector wire before and after splicing the cable to the loop wire. As an alternative, perform the circuit continuity testing of signal head cable by applying 120 volts to each outgoing circuit and observing that only the proper lamps are lighted.

E. Cable Insulation Test. Ensure that the insulation resistance measured to ground is not less than 10 megohms for each conductor of cable or wire terminating at the controller cabinet. Perform insulation testing with all conductors disconnected from their points on the terminal blocks. Measure insulation resistance for the wire of roadway loops after the embedding of the wire with sealant in slots. Include a list of the resistance readings for each conductor in the test results. After completing the cable insulation test, connect all cabinet wiring according to the wiring diagram. Demonstrate to the satisfaction of the Engineer that all circuits are continuous and operating correctly with freedom from shorts, crosses, and unintentional grounds.

F. Functional Test. Before the 10 day performance test begins, make the following checks and demonstrate to the Engineer that the system is ready for the performance test. Ensure that the incoming AC voltage is a nominal 120 volts. If the supplied voltage under load is less than 100 or more than 130 VAC, contact the power company to arrange correction. Ensure that the cabinet ventilating fan, fan

thermostat, and convenience outlet with lamp is operational. Verify correct timing settings on the controller as shown on the plans. Check all cabinet switches including the power on/off switch and flash switch. Check all controller functions to verify correct operation. Check the detector units to determine which pavement loop is associated with which detector unit. Check the visual call strength indication of detector units to determine that each vehicle class (truck, car, motorcycle, and bicycle) entering sensor areas is detected on the associated detector unit and that no extraneous calls occur when the sensor area is vacant. Occasional extraneous calls may be permitted by the Engineer if necessary to assure detection of small vehicle targets (bicycles and motorcycles). Check the flash switch to verify transfer of signal operation to flash and return to stop-and-go. Check the conflict monitor to verify that it is not activated by normal signal operations or by the manipulation of cabinet switches. If the monitor is activated, determine the cause of the problem and make appropriate changes and adjustments before beginning the performance test. Test the conflict monitor by artificially causing a number of different conflicting indications, and verify that at each test the monitor causes the signals to begin flashing and places the controller in a "stop timing" mode. Obtain artificial causation either by touching a jumper wire between two conflicting load switch outputs or by other methods approved by the Engineer. Ensure that the signal flashes when the monitor is disconnected.

G. Performance Test. At least 7 days before the performance test begins, notify the Engineer of the starting date. The Engineer will notify the maintaining agency. Before acceptance, operate the traffic control system continuously for 10 consecutive days without major malfunction or failure. Immediately replace or repair minor failures (such as lamps, a single detector unit, or an individual signal head, etc.) that do not cause restart of the test. Major malfunctions or failures (such as a master or local controller, interconnect equipment, etc.) will cause termination of the test and, after replacement or repair, the beginning of a new 10-day test. Monitor items that have been repaired or that are replacements for a 10-day period to provide assurance of their reliability. Record, for inclusion in the test result, the method and date of correction of each fault, and the beginning and end of the test.

632.29 Method of Measurement. The Department will measure Vehicular Signal Head and Pedestrian Signal Head by the number of complete units, and will include all support or mounting hardware, disconnect hangers, closure caps, dimmers, and lamps as required. Optically programmed heads shall include programming. For programming purposes, 8-inch (200 mm) programmed heads shall include one extender tool per project.

The Department will measure Pedestrian Pushbutton and Accessible Pedestrian Pushbutton by the number of individual units and will include pedestrian pushbutton signs.

The Department will measure Loop Detector Unit by the number of individual units, adjusted and tuned, and will include a wiring harness. If multi-channel detector units are used, the Department will consider each channel as an individual detector unit up to the number of units specified.

The Department will measure tether wire by the number of feet (meters) in place, and will include all necessary accessories such as pole clamps, safety tie clamps,

anchor shackles, S-hooks yielding element, thimbles, turnbuckles, guy grips, wire rope clips, lock wire, safety tie wire, lead sheet, and signal head tether anchors and extenders in accordance with the applicable Plan Insert Sheet or Standard Construction Drawing. The Department will measure from pole center to pole center, or pole center to bullring, or bullring to bullring. The Department will not measure any length of tether wire for attachment to poles or bullrings by bending, lapping or wrapping.

The Department will measure Detector Loop by the number of complete detector loops installed in the pavement, and will include pavement cutting, loop detector wire with tubing in place, application of sealant, conduit, trenching, backfilling, and surface restoration from the edge of pavement to the pull box.

The Department will measure Strain Pole Foundation, Signal Support Foundation, and Pedestal Foundation by the number of complete units, and will include excavation, dewatering, sleeving, casing, reinforcing steel, concrete, backfilling, disposal of surplus excavation, and installation only of anchor bolts and conduit ells.

The Department will measure Signal Support, Combination Signal Support, Strain Pole, Combination Strain Pole, Wood Pole, and Pedestal by the number of complete units of each, and will include pole arms, weather-heads and blind half couplings, damping device if arm length requires, anchor bolts and conduit ells furnished for foundations. The Department will measure the Luminaire Bracket Arm for each bracket arm for Combination Signal Supports and Combination Strain Poles. For combination strain poles, the luminaire bracket arm will be a separate item. For combination signal supports, the luminaire bracket arm will be a separate item.

The Department will measure Down Guy by the number of individual units, and will include messenger wire, pole clamp or thru-bolt, washer, clamps, guy grips, insulator, guy guard, and anchor.

The Department will measure Conduit Riser by the number of complete units, and will include weatherhead, conduit, fittings, clamps, and hardware.

The Department will measure Messenger Wire by the number of feet (meters) in place, and will include all necessary accessories such as, grips, thimbles, clamps, bullrings, and lashing rod. The Department will measure from pole center to pole center, or pole center to bullring, or bullring to bullring. The Department will not measure any length of messenger wire for attachment to poles, or bullrings by bending, lapping, or wrapping.

The Department will measure Signal Cable, Interconnect Cable, Loop Detector Lead-In Cable, Power Cable, and Service Cable by the number of feet (meters) in place. Cable inside of poles shall include cable support assemblies. Aerial cable shall include pole attachment hardware, splices, splice enclosures, and ground connection. Lead-in cable shall include poured epoxy insulated splices. The Department will measure: (1) horizontally from center-to-center of pull boxes, poles, cabinets, power sources, and signal heads with an additional allowance of 5 feet (1.5 m) at each pull box and terminating points for slack and connections; and (2) vertically between pole or conduit outlets. If single-conductor power cable is

substituted for multi-conductor cable, the Department will measure required length of multi-conductor cable.

The Department will measure Power Service by the number of complete units, and will include weatherhead, conduit, fittings, clamps and other necessary hardware, installation of meter base, ground wire connection, and disconnect switch(es) with enclosure and padlock.

The Department will measure Covering of Vehicular Signal Head and Covering of Pedestrian Signal Head by the number of individual signal heads covered, and will include materials and labor to erect, maintain, and remove the covering.

The Department will measure Removal of Traffic Signal Installation by the number of installations removed, and will include storage when required.

The Department will measure Removal of (*Item*) and (*Storage or Reerection*) by the number of specific traffic signal installation parts (such as a signal head, controller unit, or pole) removed, and will include storage when required.

The Department will measure Reuse of (*Item*) by the number of traffic signal equipment items reused, and will include cleaning, restoring, and relamping.

632.30 Basis of Payment. The costs to arrange service by the supply agency are included under Power Cable.

The costs of personnel, materials, equipment, electrical energy, and incidentals required to conduct performance tests are included under the contract unit price for the respective items tested.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
632	Each	Vehicular Signal Head, (Yellow or Black), (Aluminum or Polycarbonate), ___ Section ___ inch (___ mm) Lens (with Backplate)
632	Each	Vehicular Signal Head, Optically Programmed, (Yellow or Black), (Aluminum or Polycarbonate), ___-Section, ___ inch (___ mm) Lens, (with Backplate)
632	Each	Pedestrian Signal Head, (Aluminum or Polycarbonate) (Countdown), Type ___
632	Each	Pedestrian Pushbutton
632	Each	Accessible Pedestrian Pushbutton
632	Each	Loop Detector Unit
632	Each	Detector Loop
632	Each	Strain Pole Foundation
632	Each	Signal Support Foundation
632	Each	Pedestal Foundation
632	Each	Signal Support, Type TC-___, Design ___
632	Each	Combination Signal Support, Type TC-___, Design ___
632	Each	Strain Pole, Type TC-___, Design ___

632	Each	Combination Strain Pole, Type TC-___, Design ___
632	Each	Wood Pole, Class ___, (*Length*)___ feet (___ m)
632	Each	Down Guy
632	Each	Pedestal, (*Length*) ___ feet (___ m)
632	Each	Pedestal, (*Length*) ___ feet (___m),Transformer Base
632	Each	Conduit Riser, ___ inch (___ mm) Dia.
632	Foot (Meter)	Messenger Wire, (*No.*) Strand ___ inch (___ mm) Dia., with Accessories
632	Foot (Meter)	Signal Cable, ___- Conductor, ___ AWG
632	Foot (Meter)	Interconnect Cable, ___- Conductor, ___ AWG
632	Foot (Meter)	Interconnect Cable, Integral Messenger Wire Type, ___-Conductor, ___ AWG
632	Foot (Meter)	Loop Detector Lead-In Cable
632	Foot (Meter)	Power Cable, ___- Conductor, ___ AWG
632	Foot (Meter)	Service Cable, ___- Conductor, ___ AWG
632	Each	Power Service
632	Each	Covering of Vehicular Signal Head
632	Each	Covering of Pedestrian Signal Head
632	Each	Removal of Traffic Signal Installation
632	Each	Removal of (*Item*) and *(Storage Or Reerection*)
632	Each	Reuse of (*Item*)
632	Foot (Meter)	Tether Wire, with Accessories

ITEM 633 TRAFFIC SIGNAL CONTROLLERS

633.01 Description. This work consists of furnishing and installing traffic signal control equipment, including cabinets, auxiliary equipment, and specified accessories, completely wired, at the locations shown on the plans and ready for service.

633.02 Contractor Personnel Requirements. Conform to the requirements of Supplement 1063 for the installation or testing of traffic signal equipment.

633.03 Materials and Equipment. . Furnish new materials and equipment of first quality, of current design, and free from defects. For warranted items, "new" items shall have a manufacturing date (determined by serial number) within one (1) year of the date of shipment to the project as determined by the required warranty decal.

Use electrical parts, wire, switches, and other elements of the installation capable of carrying the required current without excessive heating or drop of potential.

Ensure that each item of equipment bears a nameplate, indelible marking, or brand that identifies the type, model, catalog number, and manufacturer. Use equipment conforming to the types, models, and systems specified.

Furnish material and equipment conforming to:

Concrete (cabinet foundations and work pads)
QC Misc or QC 1 ..... 499, 511
Conduit 725.04, 725.051, 725.052
Cabinet and auxiliary equipment..... 733.03
Cabinet riser 733.04
Flasher controller 733.05
Remote monitoring station 733.07
Uninterruptible Power Supply…….. 733.09

633.04 Shop Drawings. Furnish shop drawings according to 625.06.

633.05 General. Ensure that major items of traffic signal control equipment used in combination are compatible, interchangeable, and, whenever feasible, provided by the same manufacturer or supplier.

Ensure that controller cabinets are shop prewired according to 632.05.

Before starting installation, furnish to the Engineer, two copies of each cabinet wiring diagram, service manuals, and installation and maintenance instructions for each installation, including all components and interconnections. Supply one additional copy of the cabinet wiring diagrams in a clear plastic pouch fastened to the inside of the controller door. Before beginning the 10-day performance test, replace or modify these documents as necessary to reflect current conditions. Upon completion of the work and before its acceptance, replace or modify the documents as necessary.

Transfer manufacturers' guarantees or warranties on all installed traffic signal control equipment to the maintaining agency upon completion and acceptance of the project.

If required by the plans to install equipment furnished by others, store and care of the equipment upon receipt.

633.08 Cabinets. Mount cabinets by attaching to pedestal or pole or by installing on a concrete foundation. Arrange foundation mounted cabinets so that control equipment, terminal blocks, or shelves are no closer than 6 inches (150 mm) to the top of the foundation. Attach pole or pedestal mounted controller cabinets at a height that allows convenient access to all controller components by service personnel.

Make field connections for the conductors of signal cable, power cable, interconnect cable, and detector lead-in cable. Neatly arrange and route all field wiring to the appropriate terminal blocks. Identify field wiring according to 725.02 except mark with either indelible pen or embossed letters.

Except for power wiring, fit field wiring entering the cabinet with spade terminals to ensure a good connection. For incoming power wiring, either use spade terminals or connect the bare conductor wire to terminal points utilizing screw or spring applied clamping surfaces compatible with either copper or aluminum wire and providing a positive grip. After completing field wiring, seal the conduit entering the cabinet in an approved manner with a removable sealing compound (no foam sealants), or a molded plastic or rubber device that is compatible with the cable jacket, the insulation, and the conduit material.

For foundation mounted cabinets, seal the joint between the controller cabinet and the foundation with a quality, clear silicone caulk.

When future phasing configurations are shown on the plans, furnish the cabinet and hardware to accommodate the future operation through only the future addition of load switches and detector units.

Provide a riser with each ground mounted cabinet unless it is a NEMA Size 7 cabinet. Cabinet risers provide an extension of the cabinet between the ground mounted cabinet and the foundation. Bolt the riser to the foundation, and bolt the cabinet to the riser.

Use a type (size and shape) of cabinet riser compatible with the type of controller cabinets specified for the project.

Seal the joints between the controller cabinet and cabinet riser, and between the cabinet riser and foundation with a quality, clear silicone caulk.

633.10 Foundations. Construct foundations for controller cabinets according to 632.14, except that excavation by earth auger is not required and the foundation may be mass concrete that does not require reinforcing steel. Hold anchor bolts, conduit ells, and similar appurtenances in the proper position until the concrete has set. Pour foundations separately from controller work pad.

633.11 Controller Work Pad. Construct controller work pad according to 608.03, except that transverse joints are not required. Provide the top of the pad nominally 1 inch (25 mm) above ground line. If the controller cabinet has both front and back doors, the work pad shall encompass three sides of the cabinet foundation to include the non-hinged cabinet door side of the foundation. Pour controller work pad separately from foundations.

633.12 Flasher Controller. Furnish and install a flasher controller with cabinet and mounting hardware when indicated. The flasher controller is for the operation of flashing beacons.

633.15 Communications. Furnish a broadband cellular modem from the Department's Traffic Authorized Product list. The Maintaining Agency will arrange for the cellular service and device activation.

Furnish all necessary cabling to interface with the traffic signal controller. Furnish an antenna that provides RSSI (Received Signal Strength Indication) or no less than -95 dBm. Provide all necessary cabling and surge suppression to connect the antenna to the modem.

633.16 Training. Furnish training for the traffic signal control equipment installed as part of the Contract. Furnish all handouts, manuals, and product information. For the training, use the same models of equipment furnished for the project. The maintaining agency shall furnish the facilities in which the training will take place. Furnish all media and test equipment needed to present the training. Unless otherwise shown on the plans, the minimum training requirements are as follows:

A. Sixteen hours on how to operate the system, analyze system performance, and revise critical operating parameters.

B. Eight hours of field trouble-shooting and maintenance procedures.

C. Eight hours of follow-up training after the maintaining agency has operated the system for a minimum period of 30 days.

D. Four hours for preemption device training if emergency vehicle preemption is shown on the plans.

633.18 Uninterruptible Power Supply (UPS). Furnish and install a Battery Backup UPS system to provide uninterruptible, reliable, emergency power to a traffic signal intersection in the event of a power failure or interruption. The transfer from utility power to battery power shall not interfere with the normal operations of the traffic controller, conflict monitor or any other peripheral devices within the traffic control system. The system shall be self-contained including all UPS hardware, the required number of batteries and its own separate ventilated enclosure. A ground rod shall be provided for free-standing UPS cabinets.

Provide a riser with each cabinet. Cabinet risers provide an extension of the cabinet between the ground mounted cabinet and the foundation. Bolt the riser to the foundation, and bolt the cabinet to the riser.

Use a type (size and shape) of cabinet riser compatible with the type of controller cabinets specified for the project.

Seal the joints between the controller cabinet and cabinet riser, and between the cabinet riser and foundation with a quality, clear silicone caulk.

633.19 Method of Measurement. The Department will measure Cabinet, Type ___ by the number of each complete prewired cabinet installed, and will include all required auxiliary equipment and loop detector units (excluding controller unit), with all items completely wired and tested. Ground mounted cabinets will include

anchor bolts and conduit ells for installation in the foundation. Pole mounted cabinets will include pole mounting hardware. The Department will measure Cabinet, Type ___, Furnish Only by the number of each complete prewired cabinet, and will include pole mounting hardware, riser and anchor bolts, but will exclude installation, controller unit, and detector units.

The Department will measure Cabinet Foundation and Controller Work Pad by the number of each complete unit, in place, complete and accepted, and will include excavation, concrete, backfilling, and disposal of surplus excavation. Cabinet foundation will include preformed joint filler between the foundation and adjacent paved areas. One complete Controller Work Pad unit may encompass several sides of a controller cabinet installation.

The Department will measure Flasher Controller by the number of each complete flasher assembly with cabinet installed and tested.

The Department will measure Communication service by the number of each location shown on the plans for furnishing Communication service to an intersection controller, and will include the modem, conduit, trenching, and wiring.

The Department will measure Training on a lump sum basis, and will include providing the instruction materials, instructor travel expenses, and test or media equipment for presenting the training material.

The Department will measure Uninterruptible Power Supply by the number of each and will include all equipment, testing and certifications.

633.20 Basis of Payment.

The costs to obtain and maintain telephone service of cellular by the supply agency are included under Communications.

The Department will pay for accepted quantities at the contract unit prices as follows:

Item	Unit	Description
633	Each	Cabinet, Type ___
633	Each	Cabinet, Type ___, Furnish Only
633	Each	Cabinet Foundation
633	Each	Controller Work Pad
633	Each	Flasher Controller
633	Each	Communications
633	Lump Sum	Training
633	Each	Uninterruptible Power Supply

ITEM 638 WATER MAINS AND SERVICE BRANCHES

638.01 Description. This work consists of constructing water mains and service branches, including fire hydrants, water meters, corporation stops, service boxes, service stops, valves, fittings, and valve boxes, and includes:

A. Excavation for items and preparation of the foundations, necessary for placing water mains and service branches, including fire hydrants, water meters, corporation stops, service boxes, service stops, valves, fittings, and valve boxes.

B. Furnishing and placing bedding and backfill.

C. Constructing and subsequently removing all necessary cofferdams, bracing, cribs and sheeting.

D. Pumping and dewatering.

E. Providing all joints as shown in the contract documents.

F. Furnishing and installing all necessary bends and branches.

G. Furnishing and installing all necessary tracer tape.

H. Joining to existing and proposed appurtenances as required in the project plans.

I. Performing all necessary test (leakage test, disinfections, hydrostatic).

J. Restoration of disturbed underground facilities.

K. Constructing all required blocking and wedging and/or thrust blocking.

L. Furnishing and installing all necessary restraining of joints and fittings.

M. Cutting and plugging as required existing water mains to be abandoned.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

Provide a written Installation Plan per 611.04 B. for all new installations. The Installation Plan may be eliminated when utility owner installation details are

included in the contract documents. The Performance Inspection 611.12 and Conduit Evaluation 611.13 are not required.

638.02 Materials. Furnish materials conforming to:

Pipe, joints, and fittings.

Ductile iron pipe, joints, and fittings	748.01
Polyvinyl chloride (PVC) pipe, joints, and fittings	748.02
Polyethylene (PE) service branches and fittings	748.03
Glass-fiber-reinforced polymer mortar pipe and fittings	748.04
Copper service branches and fittings	748.05
Steel pipe encasement	748.06
Polyethylene encasement	748.07

Valves and equipment.

Gate valve and valve box	748.08
Inserting valve and valve box	748.09
Cutting-in sleeve, valve and valve box	748.10
Tapping sleeve, valve and valve box	748.11
Tapping saddle and corporation stop	748.12
Service stop and service box	748.13
Meter, setting, stop and chamber	748.14
Fire hydrant	748.15

Miscellaneous.

Granular Material	605.02
Disinfectant	AWWA
Pipe bedding	611.02 H
Concrete, Class QC-Misc	499 and 511
Soil and granular embankment	203.02
Structural Backfill	703.11
Mortar	602

The Engineer will allow Structural Backfill Type 3, conforming to 703.11, to be used as bedding below the pipe only when pumping operations do not control severe ground water problems. Place at least 12 inches (300 mm) of Structural Backfill Type 1 on top of the Structural Backfill Type 3 to prevent piping.

The metric equivalent pipe size may vary with material type for the same English size pipe.

638.03 Notification. Notify the Engineer and maintaining agency of the following:

A. The dates scheduled for testing and for disinfections of mains and branches.

B. Any clearances less than 1 foot (0.3 m) between new mains and existing pipes, sewers, and structures.

638.04 Excavation. Excavate according to Item 611 with the following additions:

A. Excavate the trench a suitable distance in advance of pipe laying to ensure proper clearance between the waterline and any utility crossing or underground structure. Suitably brace and support utilities and structures.

B. Excavate the trench walls vertically up to the top of the pipe. Ensure that the clearance on either side of a pipe is a minimum of 6 inches (150 mm) and a maximum of 12 inches (300 mm). In paved areas, neatly line cut the pavement at the surface a distance of at least 12 inches (300 mm) beyond the trench side and remove paving material.

C. Furnish cover over pipes of 5 feet (1.5 m) unless otherwise shown in the contract documents.

D. Pile excavated material in a manner that will not endanger the work or obstruct sidewalks and driveways. Keep gutters clear or make other satisfactory provisions for drainage. Do not obstruct natural water-courses.

E. Furnish holes for pipe bells at each joint, but make them no longer than necessary for joint assembly and assurance that the pipe barrel will be flat on the trench bottom.

F. Furnish, place, and maintain such sheeting and bracing as may be required. Immediately backfill and compact voids appearing outside of sheeting. Notify the maintaining agency of sheeting and bracing left in place. Do not remove sheeting and bracing until sufficient backfill has been placed to provide ample support to the sides of the excavation. When sheeting is left in place, cut it off at least 2 feet (0.6 m) below the proposed finished surface or subgrade in paved areas. The Department will pay for sheeting and bracing it orders to be left in place as a separate item of the work.

638.05 Pipe Bedding. Where specified, provide 4 inches (100 mm) thick Structural Backfill for bedding according to Item 611.

638.06 Pipe Laying.

A. Inspection. Inspect water mains and auxiliary equipment upon delivery in the field to ensure proper working order before installation.

B. Trench Dewatering. Where water is encountered in the trench, remove it during pipe-laying operations and maintain the trench water free until the ends of the pipe are sealed and provisions are made to prevent floating of the pipe. Do not allow trench water or other deleterious materials to enter the pipe at any time.

C. Existing Systems. Do not operate any valve or other control on the existing system. The maintaining agency will operate all valves, hydrants, air valves, and service stops.

D. Pipe Handling. Handle pipe in a manner that will prevent damage to the pipe, pipe lining, or coating. Load, unload, and place pipe and fittings using hoists and slings in a manner that will avoid shock or damage. Do not drop, skid, or roll pipe or fittings against other pipe.

E. Pipe Cutting. Whenever it becomes necessary to cut a length of pipe, make the pipe ends square with the longitudinal axis of the pipe and otherwise smooth so that good connections can be made. Cut pipe using cutters recommended by the

manufacturer. Do not cut ductile iron pipe with an oxyacetylene torch. File or grind field-cut pipe lengths to obtain a chamfer on the outside of the pipe, according to the manufacturer's recommendations. Remove rough or sharp edges from the cut end.

F. Pipe Laying. Ensure that pipe and fittings are clean when laid. Take precautions to prevent floating. Place the pipe on the trench bottom or bedding. After the pipe has been aligned and jointed, and thrust blocking has been placed, secure the pipe in place with approved backfill material. At times when pipe laying is not in progress, close the open ends of the pipe with a watertight plug.

G. Pipe Laying on Curves. If the pipe is shown curved in the contract documents, construct the curves by special fittings or by deflecting the joints according to the manufacturer's recommendations. Do not make joint deflections at valves.

When rubber-gasketed pipe is laid on a curve, joint the pipe in a straight alignment and then deflect it to the curved alignment. Make trenches wider on curves for this purpose.

H. Pipe Laying Where Earth Grading is Necessary. Where a pipe is to be placed within an embankment or the top of the pipe is above the existing ground, construct the embankment to at least 6 inches (150 mm) above the top of the pipe before trenching for the pipe. Excavate the trench to the minimum width necessary for the proper placing and backfilling of the pipe.

I. Tracer Tape. Install tracer tape over copper and non-metallic water lines, including service lines. Place the tracer tape approximately 1 foot (0.3 m) above the top of the line and extend the tape for the line's full length. Use tracer tape that is a detectable type and is marked "WATER."

J. Blocking and Wedging. Lay fire hydrants, valves, and fittings on hardwood blocks and hold them in position by hardwood wedges. Bed blocks firmly in the bottom of the trench with uniform bearing and with the long dimension of the block perpendicular to the pipe barrel. Ensure that the blocks are level across the trench and that the proper number of blocks are placed one upon the other to bring the fittings to the required grade for jointing.

K. Thrust Blocking. Furnish plugs, caps, tees, hydrants, and elbows or bends having a deflection of 11 1/4 degrees or greater with concrete thrust blocking, unless suitably restrained joints are provided. Construct the thrust blocking by placing concrete Class QC - Misc between firm original undisturbed earth and the fitting to be anchored. Place and shape the thrust blocking in a manner satisfactory to the Engineer with the thrust force contained by the blocking. Place the hardwood blocks between the plugs, caps, and hydrants, and the thrust blocking. Place the thrust blocking so that it allows for pipe and joint accessibility or repair.

L. Restrained Joints and Fittings. Where conditions at an elbow, tee, or bulkhead are not conducive to the use of thrust blocking, restrain push-on or mechanical joints and fittings by bent or straight tie-rods, straps, clamps, or other devices, with required hardware. Protect the devices against corrosion by the application of an asphalt coating. Restrain mechanical joints by a wedge action type joint restraint with twist-off nuts. If polyethylene encasement is specified, ensure

that the encasement covers the entire assembly. The Contractor may use restraining devices instead of thrust blocking when approved by the Engineer.

638.07 Pipe Joints. Furnish ductile iron pipe and cast iron or ductile iron fittings with push-on joints, mechanical joints, boltless-restrained joints, or ball-and-socket joints. Furnish joints with all accessories and install them according to the manufacturer's recommendations. During any construction where the outside temperature is below 40 °F (4 °C), keep rubber gaskets and lubricants in a heated area to at least 40 °F (4 °C) until used. Maintain gaskets in a flexible condition until placed in the bell or on the spigot of the pipe.

638.08 Backfilling. Complete backfill from the pipe grade to the finished grade, or to the subgrade surface in paved areas. Furnish and compact backfill material for water mains and appurtenances per 611.06 as described in the Installation Plan or installation details.

If hydrostatic testing is performed before the backfilling operation is completed, complete the portion of the backfill from pipe grade to the centerline of the pipe, fittings, or appurtenances and place sufficient backfill material over the pipe barrel between joints to prevent movement.

Place sand cushions at least 12 inches (0.3 m) thick between the pipe and existing pipelines or other conduits when encountered during construction and as directed by the Engineer.

638.09 Hydrostatic Tests. Apply a hydrostatic test to the whole system or to all individual valved-off sections of the mains where work has been performed. Perform the hydrostatic tests according to of AWWA, except make the test pressure greater than 150 pounds per square inch (1000 kPa). Ensure that the quantity of water lost from the main does not exceed the number of gallons (liters) per hour as determined by in AWWA or by the following formula:

$$L = \frac{ND\sqrt{P}}{7400} \qquad \left(L = \frac{ND\sqrt{P}}{130000} \right)$$

where:

L = allowable leakage, in gallons (L) per hour
N = number of joints in the length of pipe tested.
D = nominal diameter of the pipe, in inches (mm)
P = average test pressure during the leakage test, in pounds per square inch (kPa)

638.10 Disinfection of Completed Water Work. After passing the hydrostatic testing, disinfect the completed water work according to AWWA.

Make all necessary taps and furnish all equipment and labor required for the disinfections. Obtain the Engineer's approval of the time and the section of line to be disinfected.

638.11 Steel Pipe Encasement. Furnish and install a steel casing of the diameter and wall thickness shown in the plans.

Make any necessary excavation to install the steel casing. Obtain the Engineer's approval for the method of any boring or jacking operation. If placing the steel casing in an open cut trench, place it according to 638.05 and 638.08.

Join the casing pipe together with a full-circumference weld conforming to 513.21.

Ensure that the inside diameter of the casing allows the water main to be removed without disturbing the casing or roadbed. Ensure that the inside diameter of the casing is at least 2 inches (50 mm) greater than the largest outside diameter of the water main joints or couplings for carrier pipe that is less than 6 inches (150 mm). Ensure that the inside diameter is at least 4 inches (100 mm) greater than the largest outside diameter for carrier pipe 6 inches (150 mm) in diameter and over.

Install the main in the casing on hardwood blocking or stainless steel chocks designed to remain fixed in position. The Contractor may install polyvinyl chloride water main using casing insulators. Close both ends of the casing with mortared 4-inch (100 mm) bricks or a concrete bulkhead.

638.12 Polyethylene Encasement. Lay ductile iron pipe with a polyethylene encasement as shown in the contract documents. Install pipe and polyethylene encasement according to ANSI/AWWA. Any increased girth of wrapping over valves, tees, and any other irregular shaped items are included in this item without any additional payment.

638.13 Valves and Equipment. Upon delivery at the work site, open valves to prevent the collection of water in the valve. Clean the interiors of valves of all foreign matter, and inspect them in both the open and closed position before installation.

Set valves plumb and joint them to the pipe according to 638.07 and the ANSI/AWWA standards for the joint type used.

Install valve boxes on all buried valves. Center the valve box and set it in a vertical position directly over the valve nut in such a manner that the box does not transmit shock or stress to the valve. Set the base of the valve box first, and support it with a minimum backfill, hardwood blocks, or a Styrofoam collar at least 2 inches (50 mm) in thickness. Do not allow the base to rest directly on the valve or main. Use valve boxes that are two or three piece boxes with covers. When necessary, furnish extension sections. Carefully tamp backfill around the valve box to a distance of 3 feet (1 m) on all sides or to the undisturbed face of the trench if closer. Set the valve box cover flush with the ground line or finished paved surface.

Installation methods for valves and equipment include the following.

A. Gate Valve and Valve Box. Install gate valves directly in new mains or by means of a cutting-in sleeve in existing mains where maintenance of a continuous supply of water is not mandatory. Where it is mandatory not to interrupt the water supply, the Contractor may provide a branch to an existing main with a gate valve installed by means of a tapping sleeve.

B. Inserting Valve and Valve Box. Install inserting valves in existing water mains where it is mandatory not to interrupt the water supply.

Assemble the sleeve around the existing main through which water is flowing under pressure. Bolt the equipment to the sleeve, drill a hole through the existing main walls, and insert the valve, according to the manufacturer's recommendations.

C. Cutting-In Sleeve, Valve, and Valve Box. Use cutting-in sleeves to install a gate valve in an existing main, without breaking pipe joints, where it is permissible to interrupt the flow for a short period of time. Install the valve by cutting an exact length of pipe from the existing main according to the manufacturer's recommendation.

Assemble the cutting-in sleeve, its glands and gaskets, and the cutting-in valve over the cut ends of the existing pipe according to the manufacturer's recommendations.

D. Tapping Sleeve, Valve, and Valve Box. Where it is mandatory not to interrupt the water supply in an existing main and the branch is 4 inch (100 mm) or larger provide tapping sleeves.

Bolt the tapping sleeve around the existing main, assemble the tapping valve, and drill a hole through the main wall, according to the manufacturer's recommendations.

E. Tapping Saddle and Corporation Stop. Use corporation stops to provide individual service connections to mains. Ensure that the stops permit a shut-off of the service flow. Either assemble the stops directly to mains by means of a tap tool providing a tapped hole, or use a tapping saddle. Fasten the saddle around the main and drill a hole into the main by an attached drilling machine, then remove the machine and screw the stop into the saddle. Do not use corporation stops larger than 2 inches (51 mm) in size and locate them approximately 60 degrees from the top of the main.

F. Service Stop and Service Box. Install service stops in service lines to allow the shutting-off of individual services. Locate the stop beyond the pavement and provide it with a service box centered vertically over the stop operating nut such that the box provides maximum protection for the stop.

When 2 inch (51 mm) service stops are used, provide service boxes with an enlarged base. When necessary, provide extension sections for the service box to bring the box cover to finished grade.

G. Meter, Setting, Stop, and Chamber. This pay item is for meters that are to be installed in frost-proof chambers. Set the chamber on hardwood blocks. The maintaining agency shall furnish meters unless otherwise indicated by the plans. Do not transmit shock or stress to the meter body.

638.14 Fire Hydrant. The item includes excavation and furnishing and installing a new fire hydrant complete with proper jointing, blocking, and backfilling as outlined below and all other incidental work necessary to complete this item of work. The Department will pay for all hydrant branches, gate valves, and valve boxes required to perform the work separately.

A. Excavation and Drainage Pits. Excavate according to 638.04. Excavate a drainage pit 2 feet (0.6 m) in diameter and 3 feet (1 m) deep below the hydrant and fill it with granular material.

B. Setting Fire Hydrants. Provide a 3 foot (1 m) minimum radius unobstructed area around all hydrants. Set the sidewalk flange 2 inches (50 mm) above finished grade. Set hydrants on hardwood blocks according to 638.06.K. Provide thrust blocking according to 638.06.L.

Cover any hydrant not in service with a burlap or sturdy opaque plastic bag.

C. Fire Hydrant Connections. Construct hydrant branches using a section of ductile iron pipe from the main to the hydrant, and include a gate valve and valve box set vertically and placed in the line as indicated. Locate the valve a minimum of 3 feet (1 m) from the hydrant streamer connection.

D. Gate Valve and Valve Box. Provide gate valve and valve boxes for hydrant branches conforming to 638.13.

638.15 Fire Hydrant Adjusted. This item includes installing fire hydrants as described below complete with proper jointing, blocking, backfilling as outlined and all other incidental work necessary to complete this item of work. The Department will pay for all hydrant branches, gate valves, and valve boxes required to perform the work separately.

A. Fire Hydrant Extended or Adjusted to Grade. Where existing hydrants are to be adjusted to conform to new street alignment and grade, relocate the hydrant without disturbing the location of the hydrant lateral tee at the main.

Before excavating, close valves on hydrant branches to be cut. Where the distance of the center of the existing hydrant to the center of the gate valve on the hydrant branch is less than 4 feet (1.2 m), extend the trench to the hydrant branch valve to permit removal of the pipe. Adequately support the hydrant before being disconnected. Extend the hydrant branch with new pipe of the same size as the existing pipe. Thoroughly clean the removed hydrant of dirt, reset it, and connect it to the extended branch. Provide drainage pits and thrust blocking according to 638.14.A, and 638.06.L.

After hydrants have been reset, open branch and hydrant valves until water flow expels all air and dirt.

B. Fire Hydrant Removed and Reset. Where existing hydrants are indicated for removal, provide adequate support for the hydrant before disconnecting it and resetting it in the new location. Cap the existing branch line, and install adequate thrust blocking to brace the cap according to 638.06.L, unless the line is to be abandoned. Construct a new main tee, a new pipe branch, a new gate valve with valve box, with thrust blocking, and a drainage pit for the reset hydrant items. Adjust the valve box to the finished surface at the new location by raising or lowering the top portion and furnishing an extension section if needed.

C. Fire Hydrant and Gate Valve Removed and Reset. Conform to 638.15.B, except remove and reinstall the gate valve and valve box. Furnish a new tee and new pipe branch using the existing valve and box.

D. Fire Hydrant Removed and Disposed Of. Remove and dispose of fire hydrants designated for removal. Cap the existing line and place thrust blocking according to 638.06.L, unless the line is to be abandoned.

638.16 Service Branches. Furnish and install service branches, either pipe or tubing and fittings, as necessary, or as shown in the contract documents including the removal of the existing service branches or service boxes, as required according to the following situations. Tapping saddles, corporation stops, service stops, and service boxes, if required, are separate from this item:

A. Where a service branch is disturbed for lowering, raising, or relocation between the water main at the corporation stop and the service stop, replace it with new materials within these limits unless the connections can be made outside the limits of the proposed pavement, paved shoulder, or curb.

B. Where a service branch is disturbed for lowering, raising, extending, or shortening on the property side of the service stop, replace it with new materials from the existing service stop to the proposed service stop. However, if the existing service branch encountered is found to be lead or galvanized pipe, replace it from the corporation stop to the service stop with new material.

638.17 Meter and Chamber Removed and Reset. Remove and reset existing water meters and chambers as specified in 638.13.G. Remove existing chambers. Disconnect existing meters, and replace them with suitable connections if necessary. Reconnect the meters at new locations.

638.18 Valve Box and Service Box Adjusted to Grade. Raise or lower existing valve boxes and service boxes to grade or the reuse of existing service boxes.

The Contractor may reuse existing service boxes if they are in good condition, as determined by the Engineer then payment is per service box adjusted to grade.

Excavate around the valve box or service box to permit the raising or lowering of the valve box or service box. The Contractor may adjust any screw-type boxes without the use of extensions provided that ample thread remains on the box to provide adequate rigidity to the box. Provide extension sections for boxes that are not of the screw-type and boxes not having ample thread for rigidity to adjust the top to grade. The Engineer will allow inserts or adapters. Adequately secure new sections of box stem to the existing stems. Backfill the hole after the box has been adjusted to grade.

638.19 Method of Measurement. The Department will measure Water Main, Ductile Iron Pipe and Water Main, Polyvinyl Chloride Pipe and Fittings by the number of feet (meters) of each constructed.

The Department will measure Copper Service Branch, Polyethylene Service Branch, and Polybutylene Service Branch by the number of feet (meters) of each constructed.

The Department will measure Polyethylene Encasement by the number of feet (meters) of covered pipe.

The Department will measure Steel Pipe Encasement by the number of feet (meters) constructed, including the open cut or boring or jacking operation, encasement pipe, bedding and backfill, blocking to support the internal main, and end bulkheads.

The Department will measure Gate Valve and Valve Box; Inserting Valve and Valve Box; Cutting-In Sleeve, Valve and Valve Box; Tapping Sleeve, Valve and Valve Box; and Meter, Setting, Stop and Chamber separately as a complete item by the number of each.

The Department will measure Fire Hydrant, Fire Hydrant Extended and Adjusted to Grade, Fire Hydrant Adjusted to Grade, Fire Hydrant Removed and Reset, Fire Hydrant and Gate Valve Removed and Reset, and Fire Hydrant Removed and Disposed Of separately by the number of each.

The Department will measure Valve Box Adjusted to Grade and Service Box Adjusted to Grade separately by the number of each, including any extension sections of valve or service boxes required.

The Department will measure Meter and Chamber Removed and Reset by the number of each.

The Department will measure Sheeting and Bracing Ordered Left In Place in thousands of board feet, MBF (cubic meters).

638.20 Basis of Payment. The Department will pay for accepted quantities at the contract unit prices as follows:

Item	Unit	Description
638	Foot (Meter)	___ inch (___ mm) Water Main, Ductile Iron Pipe, ANSI Class___, (push-on, mechanical, boltless- restrained, ball-and-socket) Joints and Fittings
638	Foot (Meter)	___ inch (___ mm) Water Main, Polyvinyl Chloride Pipe and Fittings, ASTM SAR ___ or AWWA Class ___
638	Foot (Meter)	___ inch (___ mm) Copper Service Branch
638	Foot (Meter)	___ inch (___ mm) Polyethylene Service Branch
638	Foot (Meter)	___ inch (___ mm) Polybutylene Service Branch
638	Foot (Meter)	Polyethylene Encasement
638	Foot (Meter)	___ inch (___ mm) Steel Pipe Encasement, (open cut, bored or jacked)
638	Each	___ inch (___ mm) Gate Valve and Valve Box
638	Each	___ inch (mm) Inserting Valve and Valve Box
638	Each	___ inch (mm) Cutting-In Sleeve, Valve and Valve Box
638	Each	___ inch × ___ inch (___ mm × ___ mm) Tapping Sleeve, Valve and Valve Box
638	Each	Meter, Setting, Stop and Chamber
638	Each	___ inch (___ mm) Fire Hydrant
638	Each	Fire Hydrant Extended and Adjusted to Grade
638	Each	Fire Hydrant Adjusted to Grade
638	Each	Fire Hydrant Removed and Reset

638	Each	Fire Hydrant and Gate Valve Removed and Reset
638	Each	Fire Hydrant Removed and Disposed Of
638	Each	Valve Box Adjusted to Grade
638	Each	Service Box Adjusted to Grade
638	Each	Meter and Chamber Removed and Reset
638	MBF (Cubic Meter)	Sheeting and Bracing Ordered Left In Place

640 PAVEMENT MARKING

ITEM 641 PAVEMENT MARKING—GENERAL

641.01 Description. This specification gives general requirements for various kinds of retroreflective pavement markings. Deviations from these general requirements are covered in the specific requirements for each marking type.

Place all pavement markings according to the OMUTCD.

641.02 Materials. Use marking materials that are a formulation, identified by a manufacturer's code number, prequalified by the Laboratory and that have the same composition as the prequalified marking material.

Any materials delivered without a TE-24 when applicable and applied without Laboratory preapproval shall be removed. Laboratory tested materials not meeting specifications shall be removed from the project site.

Furnish a safety data sheet (SDS) for each material, including resin, catalyst, primer, adhesive, activator, glass beads, and cleaning solvent, to be used on the project to the Engineer before material delivery. Inform workers of the location of all SDS and allow workers an opportunity to review them.

Furnish the Engineer, prior to application, the paint manufacturer's printed application equipment requirements and application instructions.

641.03 General. Apply lines as solid, broken, or dotted lines, either singly or in combination, as shown on the plans. Apply broken lines in a 40 foot (12.0 m) cycle consisting of a 10 foot (3.0 m) dash and a 30 foot (9.0 m) gap between broken lines, unless otherwise shown on the plans. Use an accurate striping mechanism that is capable of being easily adjusted to retrace existing broken markings or to apply new materials at the correct spacing. Begin broken lines that are to be applied over plainly visible existing broken lines within 6 inches (150 mm) of the beginning of the existing broken line, unless otherwise directed by the Engineer. Apply dotted lines in an 8 foot (2.4 m) cycle consisting of a 2 foot (0.6 m) dot and a 6 foot (1.8 m) gap

between dots for line extensions and in a 12 foot (3.6 m) cycle consisting of a 3 foot (0.9 m) line segment and a 9 foot (2.7 m) gap for lane drop/add markings.

Fill gaps that were not marked as a result of template use for spray-applied auxiliary markings with marking material after the template is removed. If applying extruded thermoplastic, the Contractor may leave small gaps in arrows or letters resulting from template use unfilled.

Ensure that pavement markings are free of uneven edges, overspray, or other readily visible defects that detract from the appearance or function of the pavement markings.

Ensure that lines are sharp, well defined, and uniformly retroreflective. Apply the lines to the width specified ±1/4 inch (6 mm). Fuzzy lines, excessive overspray, or non-uniform application are unacceptable. The Engineer will inspect lines at night to verify proper retroreflectivity. Correct pavement markings that are improperly applied, located, or reflectorized. Reapply lines applied with insufficient material quantities according to 641.11, 644.04 or 648.05. Remove improperly located lines according to 641.10, and apply new lines in the correct locations.

Reapply any lines applied with non-specification materials.

Obtain the Engineer's approval for methods and equipment used for pavement preparation, marking, and marking removal. Keep glass beads dry during storage and before use.

Furnish to the Engineer at least 3 days in advance of installation current copies of the manufacturer's instructions and recommendations for application of any marking material, including primer, activator, catalyst, and adhesive, shown on the plans. Schedule and perform other construction work, such as shoulder paving, seeding, and mulching in a manner to avoid damage to applied pavement markings.

Do not apply pavement marking materials to the reflector of a plowable raised pavement marker. Interrupt the application of the pavement marking line at each raised pavement marker where marking material would otherwise be applied to the marker's prismatic reflector. Provide a maximum gap in the marked line of 18 inches (0.5 m) at each marker. Remove pavement marking material applied to a prismatic reflector surface, or replace the reflector that same workday. If material must be removed from the reflector, restore the reflector's brightness to its prior condition.

641.04 Equipment. Equip long line pavement marking equipment with a computerized Data Logging System (DLS), including a cab mounted display. For center line, lane line, and edge line markings, when the length of marking exceeds 0.5 mile (0.8 km) of continuous line equivalent, provide the Table 641.04-1 DLS capabilities.

TABLE 641.04-1

Provide the highway number with the county and beginning and ending county log points rounded to the nearest thousandths of a mile, the beginning and ending coordinates determined by a Global Positioning System receiver with at least 16 foot accuracy, and the direction of travel in terms of increasing or decreasing county log points. The Department will provide mapping information downloadable through Transportation Information Mapping System (TIMS) online LRS layer at https://gis.dot.state.oh.us/tims
Provides cellular capabilities for field data transport to website.
Provide GPS mapping system that is capable of real time (within 20 minute) tracking of the Department cloud DLS report format, Table 641.04-2 requirements, and color coded alarms for a 20 percent deficiency in film thickness, bead rate, and wet reflective optic rate.
Send report to the Engineer or their designated representative by email at 7:00 AM the day after the work is completed.
Transfer raw data collected by the DLS directly to a secure server.
Provide flagging of data entered manually.
Ensure the DLS manufacturer provides a Department login with direct access to stored data summary on a secure password protected website.

Record as a separate DLS report line entry the Table 641.04-2 information for each route section marked, when the length of center line, lane line and edge line marking exceeds 0.5 mile (0.8 km) of continuous line equivalent. A route section is defined as one direction of a contiguous section of highway (without breaks) with the same route number designation. Continuous line equivalent is defined as 0.5 mile (0.8 km) of edge line, 0.25 mile (0.4 km) of double yellow center line, or 2 mile (3.2 km) of lane line. DLS documentation is not required for center line, lane line, and edge line markings of 0.5 mile (0.8 km) continuous line equivalent or less, and for channelizing lines of any length.

If the DLS equipment fails, finish that day's work only and resume when the DLS equipment is working. Provide documentation of the corrective work that was required to make the DLS and ancillary equipment operational. Repair the DLS before resuming work. Document the application and material usage quantities from the time of the DLS failure and make calculations to determine the gallons or pounds of binder per mile and pounds of beads, wet reflective optics, or both per mile.

The Department will provide a standard DLS long report form (CA-T-9, CA-T-10, CA-T-11, or CA-T-12), that prescribes the correct DLS report format and required content prior to beginning of work. Ensure the DLS records start time once the project or report line is started and the first gun is on. In addition to the Department DLS report format required content, document in accordance with the DLS at least the Table 641.04-2 requirements.

TABLE 641.04-2 ADDITIONAL DLS REPORT REQUIREMENTS.

Measure and record application vehicle speed to nearest 0.1 MPH (0.16 km/h),
Measure and record weight or volume of material used by color,
Measure and record weight or volume of material used by line type,
Measure and record weight or volume of material used by line width.

. The DLS must store data and export to a secure server on a daily basis. Ensure the data is in Microsoft Excel format, or a comma or spaces delimited text file adequate for insertion into a computerized spreadsheet. Ensure the DLS manufacturer provides the Engineer a direct access login to the data being exported to the secure server. Provide data in the Department cloud DLS report format. Ensure the data is available to the Engineer within 24 hours of the pavement marking work and may be retrieved by the Engineer or designated field personnel for inclusion with documentation reporting. Ensure the electronic records are completed in their final form prior to the records being removed from the pavement marking equipment.

Ensure each DLS has at least an annual calibration of all mechanical and electrical components and its software function and output confirmed by the DLS manufacturer or their designated representative. Ensure evidence of the annual calibration is carried by a signed and dated stamp or seal affixed to the inside of the driver's door of each striper.

A. Traffic Paint, Polyester, Epoxy. Ensure the cab mounted display shows the actual material application rate and film thickness.

B. Thermoplastic, Spray Thermoplastic. Ensure the cab mounted display shows the actual bead application rate.

Use application equipment that includes a kettle for melting the thermoplastic material and maintaining it at the proper temperature. Equip the kettle with a thermostat to control the temperature of the melted thermoplastic material and to prevent overheating. Use equipment that continuously mixes and agitates the molten thermoplastic material. Ensure that the parts of the equipment that convey the thermoplastic material from the kettle to the application point maintains it at the required temperature.

Attach an automatic dispenser for glass beads, wet reflective optics, or both to the equipment so that the beads, optics, or both are immediately and uniformly dispensed over the marking surface. Equip the dispenser with an automatic cut-off control synchronized with the cut-off of the thermoplastic material.

641.05 Pavement Preparation. Clean all visible loose or foreign material from the surface to be marked. Equip the pavement marking equipment with an air jet to remove all debris from the pavement in advance of the applicator gun. Operate the air jet when marking material is being applied, and synchronize it with marking material application. Power-broom clean all surfaces where gore markings or edge lines are to be applied. If required by the Engineer, also power-broom clean other surfaces. Do not apply marking to portland cement concrete until the concrete in the areas to be marked is clean of membrane curing material and is dry.

Before applying marking material, the pavement surfaces must be completely dry. Test for moisture using the following test procedures, if needed as directed by the Engineer.

MOISTURE TEST

Tape a 12 inch (300 mm) square sheet of thin plastic to the road surface, sealing all edges.
After 15 minutes examine the side of the sheet facing the road surface.
If more than a sparse amount of moisture is present, do not apply marking material.

641.06 Layout and Premarking. Lay out the locations of all lines, words, and other symbols to ensure their proper placement. Do not start marking operations until the Engineer or the Engineer's representative has approved the layout and premarking lines If applying longitudinal or transverse lines, use existing lines, construction joints, or premarking to guide this marking equipment.

On projects where resurfacing or other operations will result in obliteration of the existing pavement markings, establish reference points to ensure proper placement of restored markings. If existing markings are to be retraced, verify any adjustment in the location with the Engineer.

Establish "T" marking of no-passing zones according to the plans or a no-passing zone log provided by the Engineer.

Locate premarking from survey data or reference points, and offset it so as to parallel the theoretical edge of the marking lines at a maximum distance of 1 inch (25 mm). Use templates for the layout of arrows, words, and other symbols. Place premarking for longitudinal lines at 40 foot (12 m) intervals, and do not exceed 2 inches (50 mm) in width or 12 inches (300 mm) in length. Locate premarking for auxiliary markings from the plans or schematic forms provided by the Engineer.

641.07 Line Placement Tolerance. Ensure that pavement marking lines are straight or smoothly curved, true to the alignment of the pavement, and do not deviate laterally from the proper location at a rate of more than 2 inches in 100 feet (50 mm in 30 m). The Engineer will not allow any deviation greater than 3 inches (75 mm). Remove improperly located lines according to 641.10 and apply new lines in the correct locations.

641.08 Marking Types. Apply marking materials at the rate or thickness specified in 642.04, 643.04, 644.04, 645.03, 646.05, 647.04, or 648.05 and, except for parking lot stall markings, ensure that they are uniformly retroreflective. Ensure that portions of parking stalls that are adjacent to street traffic are retroreflective. Pavement markings consist of the following types:

A. Edge Lines. Place edge lines as continuous stripes using the width specified. Locate the center of the stripe 6 inches (150 mm) from the edge of pavement. Ensure that the right edge line is applied to the left of the right edge of pavement. Ensure that the left edge line is applied to the right of the left edge of pavement.

B. Lane Lines. Place lane lines using the width specified, as white stripes between contiguous lanes of pavement carrying traffic in the same direction. Place them as broken lines unless specified solid. Offset lane lines to the left of the

longitudinal joint, if present, or the theoretical line lying between contiguous lanes, if a joint is not present. Ensure that the nearer edge of the stripe is 2 inches (50 mm) to the left of the joint or line. Do not place lane lines through intersections.

C. Center Lines. Place center lines as single or double yellow stripes between contiguous lanes of pavement carrying traffic in opposite directions. Center line marking includes two-way left-turn lane striping and the outline of left-turn islands. Make each stripe 4 inches (100 mm) wide, solid or broken as specified.

D. Channelizing Lines. Place channelizing lines as continuous white stripes, using the width specified.

E. Stop and Crosswalk Lines. Place stop lines as solid 24-inch (600 mm) wide white stripes. Place crosswalk lines as solid 12-inch (300 mm) wide white stripes.

F. Transverse/Diagonal Lines. Place transverse/diagonal lines as solid 24-inch (600 mm) wide stripes, of the color specified, and at an angle to the direction of travel.

G. Curb and Island Marking. Prepare exposed surfaces and curbs and paved islands according to 641.05. In addition, remove and dispose of all visible loose or foreign material, including vegetation, on and immediately contiguous to surfaces to be marked.

H. Symbol Markings. Place all railroad, school, bicycle and handicap symbol markings using white markings. A railroad marking includes the 16 inch (400 mm) crossbuck, two 72 inch (1.8 m) "R"s, two 24 inch (600 mm) transverse lines, and a stop line. A school marking includes the word "SCHOOL" and two 16 inch (400 mm) transverse lines. A shared lane marking includes the bicycle symbol and two sharrows. A bicycle crossing symbol includes the bicycle symbol and the word "XING".

I. Parking Lot Stall Marking. Place parking lot stall marking lines as continuous 4-inch (100 mm) wide white stripes.

J. Lane Arrows. Place lane arrows using white markings.

K. Words on Pavement. Place words on pavement using white markings.

L. Dotted Lines. Place dotted lines using the width and color specified.

M. Yield Lines. Place yield lines as solid white 24-inch (600 mm) isosceles triangles pointing toward approaching traffic.

The term long lines, when used in sections 642 through 648 includes edge lines, lane lines, center lines, and channelizing lines over 200 feet (60 m) long. The term auxiliary markings, when used in Items 642 through 648 includes channelizing lines 200 feet (60 m) or shorter, stop lines, yield lines, crosswalk lines, transverse lines, diagonal lines, curb markings, island markings, symbol markings, parking lot stall markings, lane arrows, and dotted lines.

641.09 Two-Way Radio Communications. If two-way radio equipment is required, furnish and maintain radio equipment necessary for the voice communication between the striper and the inspector's vehicle at all times during

the pavement marking operation. Use equipment capable of transmitting and receiving normal voice communications to at least 4 miles (6 km).

641.10 Removal of Pavement Markings. If specified as a pay item, remove pavement markings as described in 614.11.G. Take care during marking removal not to scar, discolor, or otherwise damage the pavement surface. Do not overpaint or use other methods of covering markings instead of removal.

641.11 Unsatisfactory Materials and Deduction for Deficiency. For traffic paint, polyester and epoxy, the Engineer will compute each day the amount of marking material (including all components) and glass beads applied for each route section on the DLS report for determining unsatisfactory sections. The Department will reduce the contract price for each route section in direct proportion to the percent of deficiency of marking material or glass beads as specified in 642.04, 643.04 and 646.05, up to 20 percent for each material deficiency. The Department will only use the greater deficiency of marking material or glass beads to compute the deduction.

The Department will consider materials unsatisfactory if at least one of the following conditions is met:

A. Deficiency of marking material or glass beads is 20 percent or more.

B. Materials applied outside the temperature or application requirements in Items 642, 643, and 646 without written approval of the Engineer.

C. Markings not meeting the performance parameters contained in Supplement 1047, Appendices C, D, E, G, or a combination of the Appendices.

1. Numerical rating of 8 or lower for Daytime Color (Appendix C)
2. Composite rating of 8 or lower for Night Visibility (Appendix D)
3. Numerical rating of 9 or lower for Durability (Appendix E)
4. Less than the initial measurement for Retroreflectivity (Appendix G)

Replace pavement markings and glass beads in all sections determined to be unsatisfactory by retracing over the unsatisfactory markings at the full thickness specified in Items 642, 643 and 646..

641.12 Method of Measurement. The Department will measure pavement markings complete in place in the units designated. The Department will measure line quantities as the length of completed marking, including the gaps, intersections, and other sections of pavement not normally marked. The Department will measure Two-Way Left Turn Arrow as one pair of two opposing left turn arrows. The Department will measure the removal of pavement markings using the same method of measurement as completed markings in the units designated.

641.13 Basis of Payment. The Department will pay for accepted quantities of work performed under Items 642, 643, 644, 645, 646, 647 and 648.

The Department will not pay for costs associated with correcting improperly located lines, replacing reflectors coated with pavement marking material, or replacing unsatisfactory pavement markings.

The Department will not pay for lines placed using non-specification materials.

The Department will not pay for non-specification lines determined through field measurement.

The Department will pay for Two-Way Radio Equipment at the lump sum bid price.

ITEM 642 TRAFFIC PAINT

642.01 Description. This work consists of furnishing and applying fast dry water-based traffic paint or fast dry water-based traffic paint for cold weather applications according to Item 641, 740.01, 740.02, 740.09, and the additional requirements specified below.

642.02 Materials. Furnish materials conforming to:

Traffic Paint 740.02
Glass Beads, Type A..... 740.09

The Engineer may obtain random samples from the application equipment in accordance with supplement 1089. Furnish the manufacturer's identification information for the sampled liquid materials. The Department will test the quality assurance sample for conformance to the manufacturer's production ranges. Samples not meeting the manufacturer's production ranges will require the Contractor to re-apply, at his expense, any markings using that sample. All other untested batches will become not approved and will either require testing or re-application.

Do not apply paints that have exceeded the manufacturer's shelf life. Do not use glass beads that are wet.

642.03 Equipment. Use equipment capable of applying the traffic paint as recommended by the manufacturer and applying glass beads at the time of line placement. Furnish a calibrated measuring device acceptable to the Engineer to measure the traffic paint in the striper tanks.

Equip all striping equipment for center line, lane line and edge line markings with a computerized Data Logging System (DLS) conforming to 641.04 when the length of marking exceeds 0.5 miles (0.8 km) of continuous line equivalent.

Furnish written documentation to the Engineer for the equipment's operational capabilities from the equipment manufacturer.

642.04 Application. Apply pavement markings only when the surface is clean and dry in accordance with the paint manufacturer's written application instructions.

If application is required when air and pavement temperatures are between 35 °F (2 °C) and 50 °F (10 °C) obtain approval from the Engineer and apply only pre-qualified Type 1A cold weather traffic paint materials. Furnish the Engineer documentation the material being delivered is within the manufacturer's recommended shelf life from the date of manufacture. Apply traffic paint according to the manufacturer's recommendations and protect line from tracking.

Keep the paint thoroughly mixed during application.

Apply 20 mil (0.51 mm) thick traffic paint Type 1 at the following rates:

20 Mil Thickness	Line Width (inch)				
	4	6	8	12	24
	Gallon per Mile of Line				
Solid Line	22	33	44	66	132
Broken Line	5.5	8.25	11	16.5	33
Dotted Line	5.5	8.25	11	16.5	33
Areas, Symbols, Words	1.25 gallon per 100 square feet				

0.51 mm Thickness	Line Width (mm)				
	100	150	200	300	600
	Liter per Kilometer of Line				
Solid Line	50	75	100	150	300
Broken Line	12.5	19	25	38	75
Dotted Line	12.5	19	25	38	75
Areas, Symbols, Words	0.51 L/m²				

Apply 15 mil (0.38 mm) thick traffic paint Type 1A at the following rates:

15 Mil Thickness	Line Width (inch)				
	4	6	8	12	24
	Gallon per Mile of Line				
Solid Line	16	24	32	48	96
Broken Line	4	6	8	12	24
Dotted Line	4	6	8	12	24
Areas, Symbols, Words	0.94 gallon per 100 square feet				

0.38 mm Thickness	Line Width (mm)				
	100	150	200	300	600
	Liter per Kilometer of Line				
Solid Line	37	56	74	111	222
Broken Line	9.3	14	18.6	28	56
Dotted Line	9.3	14	18.6	28	56
Areas, Symbols, Words	0.38 L/m²				

Do not dilute the paint. However, the Contractor may add spent traffic paint solvents, generated during performance of this work, to virgin traffic paint. If adding spent solvents, add them in a maximum ratio of 1:50 of spent solvents to virgin paint. Ensure that the maximum concentration of spent solvents in the striping equipment tanks is maximum 2 percent. Add spent solvents during the loading of the striping equipment.

Apply glass beads to the wet paint so that the beads are embedded and retained in the paint and provide uniform retroreflectivity in the paint surface. Apply glass beads at a minimum rate of 15 pounds per 100 square feet (7.3 kg per 10 m^2) for Type 1 traffic paint. Apply glass beads at a minimum rate of 8.0 pounds per 100 square feet (3.9 kg per 10 m^2) for Type 1A traffic paint.

Ensure temperature of the paint at the discharge point is within the range recommended by paint manufacturer.

Replace unsatisfactory markings according to 641.11.

Furnish the Engineer daily, biweekly and final DLS reports according to 641.04.

Perform traffic control operations for all 642 pavement markings according to 614.12 and MT-99.20M, but provide for center line, edge line, lane line and channelizing line traffic control equipment according to MT-99.20M equipment requirements for center line, longer than 2 minute dry.

Payment for this work shall be included in the 642 price per mile for Center Line, Edge Line and Lane Line and the 642 price per foot for channelizing Line.

642.05 Basis of Payment. The Department will pay for accepted quantities at the contract prices, or prices adjusted according to 641.11, measured according to 641.12, with the provisions specified in 641.13, and as follows:

Item	Unit	Description
642	Mile (Kilometer)	Edge Line, ___ inch (___ mm), Type ___
642	Mile (Kilometer)	Lane Line, ___ inch (___ mm), Type ___
642	Mile (Kilometer)	Center Line, Type ___
642	Foot (Meter)	Channelizing Line, ___ inch (___ mm), Type ___
642	Foot (Meter)	Stop Line, Type ___
642	Foot (Meter)	Yield Line, Type___
642	Foot (Meter)	Crosswalk Line, Type ___
642	Foot (Meter)	Transverse/Diagonal Line, Type ___
642	Foot (Meter)	Curb Marking, Type ___
642	Square Foot (Square Meter)	Island Marking, Type ___
642	Each	Handicap Symbol Marking, Type ___
642	Each	Railroad Symbol Marking, Type ___
642	Each	School Symbol Marking, ___ inch (___ mm), Type ___
642	Each	Bicycle Lane Symbol Marking, Type___
642	Each	Shared Lane Marking, Type____
642	Foot (Meter)	Parking Lot Stall Marking, Type ___
642	Each	Lane Arrow, Type ___
642	Each	Word on Pavement, ___ inch (___ mm), Type ___
642	Foot (Meter)	Dotted Line, ___ inch (___mm), Type ___
642	Foot or Square Foot (Meter or Square Meter), or Each	Removal of Pavement Marking
642	Lump Sum	Two-Way Radio Equipment

ITEM 643 POLYESTER PAVEMENT MARKING

643.01 Description. This work consists of furnishing and applying polyester pavement markings according to Item 641, 740.01, 740.03, 740.09, and the additional requirements specified below.

643.02 Materials. Furnish materials conforming to:

Polyester Pavement Marking 740.03
Glass Beads, Type B 740.09

The Engineer may obtain random samples from the application equipment in accordance with supplement 1089. Furnish the manufacturer's identification information for the sampled liquid materials. The Department will test the quality assurance sample for conformance to the manufacturer's production ranges. Samples not meeting the manufacturer's production ranges will require the Contractor to re-apply, at his expense, any markings using that sample. All other untested batches will become not approved materials and will either require testing or re-application.

Do not apply material that have exceeded the manufacturer's shelf life. Do not use glass beads that are wet.

643.03 Equipment. Use application equipment capable of mixing the polyester components in proportions recommended by the manufacturer and applying glass beads at the time of marking placement. Use equipment (striper) capable of applying polyester long-lines at the thickness specified for solid and broken lines while moving on the highway at a speed of not less than 7 miles per hour (11 km/h). Furnish a calibrated measuring device acceptable to the Engineer to measure the polyester resin in the striper tanks.

Equip all striping equipment for center line, lane line and edge line markings with a computerized Data Logging System (DLS) conforming to 641.04 when the length of marking exceeds 0.5 miles (0.8 km) of continuous line equivalent. The DLS shall measure the polyester resin material component and glass beads only. Catalyst will be calculated as 2 percent of the resin used.

Furnish written documentation to the Engineer for the equipment's operational capabilities from the equipment manufacturer.

643.04 Application. Apply polyester only when the pavement surface is clean and dry and the pavement and air temperature are above 50 °F (10 °C).

If project safety requirements require marking application below 50°F (10°C), obtain approval from the Engineer and apply cold weather traffic paint, Type 1A, according to Item 642 instead of the polyester.

Ensure that the polyester is thoroughly mixed at all times during application. Apply polyester (catalyst plus resin) uniformly to the pavement at the following rates:

15 Mil Thickness	Line Width (inch)				
	4	6	8	12	24
	Gallon per Mile of Line				
Solid Line	16	24	32	48	96
Broken Line	4	6	8	12	24
Dotted Line	4	6	8	12	24
Areas, Symbols, Words	0.94 gallon per 100 square feet				

0.38 mm Thickness	Line Width (mm)				
	100	150	200	300	600
	Liter per Kilometer of Line				
Solid Line	37	56	74	111	222
Broken Line	9.3	14	18.6	28	56
Dotted Line	9.3	14	18.6	28	56
Areas, Symbols, Words	0.38 L/m²				

Do not dilute the material.

Apply glass beads to the uncured polyester in sufficient quantity so that the beads completely fill the polyester film from the film-pavement interface to the top surface of the film to the extent that there are loose beads on the surface of the uncured line. Apply glass beads at a minimum rate of 16.5 pounds per 100 square feet (8 kg per 10 m^2) of polyester applied in a manner that provides uniformly retroreflective lines.

If the applied polyester becomes tacky and causes marking discoloration and darkening, cease marking application until the Engineer agrees that the problem is corrected.

If any marking is in a tracking condition 45 minutes after application, cease marking application until the Engineer agrees that the problem is corrected.

Do not apply polyester pavement markings to new asphalt concrete until at least 2 weeks after the pavement is placed. Assure curing compound is removed from portland cement concrete pavements.

Replace unsatisfactory markings according to 641.11.

Furnish the Engineer daily, biweekly and final DLS reports according to 641.04.

643.05 Basis of Payment. The Department will pay for accepted quantities at the contract prices, or prices adjusted according to 641.11, measured according to 641.12, with the provisions specified in 641.13, and as follows:

Item	**Unit**	**Description**
643	Mile (Kilometer)	Edge Line, ___ inch (___ mm)
643	Mile (Kilometer)	Lane Line, ___ inch (___ mm)
643	Mile (Kilometer)	Center Line
643	Foot (Meter)	Channelizing Line, ___ inch (___ mm)
643	Foot (Meter)	Stop Line
643	Foot (Meter)	Yield Line

643	Foot (Meter)	Crosswalk Line
643	Foot (Meter)	Transverse/Diagonal Line
643	Foot (Meter)	Curb Marking
643	Square Foot	Island Marking (Square Meter)
643	Each	Handicap Symbol Marking
643	Each	Railroad Symbol Marking
643	Each	School Symbol Marking, ___ inch (___ mm)
643	Each	Bicycle Lane Symbol Marking
643	Each	Shared Lane Marking
643	Foot (Meter)	Parking Lot Stall Marking
643	Each	Lane Arrow
643	Each	Word on Pavement, ___ inch (___ mm)
643	Foot (Meter)	Dotted Line, ___ inch (___ mm)
643	Foot or Square Foot (Meter or Square Meter), or Each	Removal of Pavement Marking
643	Lump Sum	Two-Way Radio Equipment

ITEM 644 THERMOPLASTIC PAVEMENT MARKING

644.01 Description. This work consists of furnishing and applying screed extruded or ribbon gun thermoplastic pavement markings according to Item 641, 740.01, 740.04, 740.09, and the additional requirements specified below.

644.02 Materials. Furnish materials conforming to:

Thermoplastic pavement marking..... 740.04
Glass beads, Type C..... 740.09

The Engineer may obtain random samples from the application equipment in accordance with supplement 1089. Furnish the manufacturer's identification information for the sampled liquid materials. The Department will test the quality assurance sample for conformance to the manufacturer's production ranges. Samples not meeting the manufacturer's production ranges will require the Contractor to re-apply, at his expense, any markings using that sample. All other untested batches will become not approved materials and will either require testing or re-application.

Do not apply material that has exceeded the manufacturer's shelf life. Do not use glass beads that are wet.

644.03 Equipment. When using thermoplastic pavement marking trucks, equip all thermoplastic pavement marking trucks for center line, lane line and edge line markings with a computerized Data Logging System (DLS) conforming to 641.04

when the length of marking exceeds 0.5 mile (0.8 km) of continuous line equivalent. A DLS is not required for markings applied with hand carts.

Ensure that the application equipment applies lines with a square end and can apply broken lines. Furnish application equipment for applying markings that consists of dies of varying widths to produce different widths of lines. Do not use pans, aprons, or similar devices that the die overruns.

Use equipment that ensures uniformity in the thickness and width of lines. Use equipment that forms lines 12 inches (300 mm) wide or less by one application pass, and lines wider than 12 inches (300 mm) by no more than two passes. Do not allow individual passes to overlap or to be separated by a gap greater than 1/4 inch (6 mm).

644.04 Application. If applying thermoplastic to pavements that are less than six months old, ensure that both the pavement surface and the ambient air temperature at the time of application are not less than 50 °F (10 °C) and rising. However, if applying thermoplastic to pavements that are older than six months, ensure that both the pavement surface and the ambient air temperature at the time of application are not less than 70 °F (21 °C) and rising. Ensure that the temperature of thermoplastic at the point of application is at least 400 °F (204 °C) and not more than 440 °F (227 °C).

Apply thermoplastic at a thickness of 125 mils (3.2 mm). Thermoplastic for small quantities or auxiliary markings up to 100 feet (30 m) in length can be exchanged as equal in function and price with 125 mil (3.2 mm) thick heat-fused preformed thermoplastic (Item 647).

Apply thermoplastic at the following rates:

125 Mil Thickness	**Line Width (inch)**				
	4	**6**	**8**	**12**	**24**
	Pounds per Mile of Line				
Solid Line	2340	3510	4680	7020	14040
Broken Line	585	878	1170	1755	3510
Dotted Line	585	878	1170	1755	3510
Areas, Symbols, Words	133 pounds per 100 square feet				

3.2 mm Thickness	**Line Width (mm)**				
	100	**150**	**200**	**300**	**600**
	Kilograms per Kilometer of Line				
Solid Line	650	975	1300	1950	3900
Broken Line	165	245	325	490	975
Dotted Line	165	245	325	490	975
Areas, Symbols, Words	6.5 kg/m²				

Mechanically apply glass beads to the wet thermoplastic surface so that the beads are embedded and retained and provide uniform retroreflectivity in the surface. Do not place beads by hand, except to symbols and words, and to complete the ends of

lines. Apply beads at a minimum rate of 12 pounds per 100 square feet (6 kg per 10 m^2) of thermoplastic surface area. The Contractor may leave small gaps unfilled in symbols and letters resulting from template use.

If required, furnish primer, and apply it according to the manufacturer's recommendations. Use primer except on new asphalt pavement.

For each route section on the DLS report, the Engineer will compute the amount of thermoplastic marking material and glass beads applied. The Department will reduce the contract price in direct proportion to the percent of deficiency of thermoplastic marking material or glass beads as specified in 644.04, up to 20 percent for each material deficiency. The Department will only use the greater deficiency of marking material or glass beads to compute the deduction.

The Department will consider materials unsatisfactory if at least one of the following conditions is met:

A. Deficiency of thermoplastic marking material or glass beads is 20 percent or more.

B. Materials applied outside the temperature or application requirements in 644.04 without written approval of the Engineer.

C. Markings not meeting the performance parameters contained in Supplement 1047, Appendices C, D, E, and G.

1. Numerical rating of 8 or lower for Daytime Color (Appendix C)
2. Composite rating of 8 or lower for Night Visibility (Appendix D)
3. Numerical rating of 9 or lower for Durability (Appendix E)
4. Less than the initial measurement for Retroreflectivity (Appendix G)

Replace thermoplastic markings and glass beads in all sections determined to be unsatisfactory by entirely removing the unsatisfactory thermoplastic material by grinding as per 641.10 and then reapplying at the full thickness specified in 644.04. Do not apply a layer of sprayed thermoplastic to sections determined to be unsatisfactory to achieve the required thickness.

Furnish the Engineer daily, biweekly and final DLS reports conforming to 644.03, and additional reports indicating material type and quantities in pounds (kilograms) of thermoplastic materials used, according to 641.04.

644.05 Layout and Premarking. In addition to the requirements specified in 641.06, only place auxiliary markings on new pavement. The Contractor may place initial thermoplastic markings over work zone traffic paint markings.

644.06 Basis of Payment. The Department will not pay for any thermoplastic lines that do not meet the required thickness. The Department will pay for accepted quantities at the contract prices, or prices adjusted according to 644.04, measured according to 641.12, with the provisions specified in 641.13, and as follows:

Item	Unit	Description
644	Mile (Kilometer)	Edge Line, ___ inch (___ mm)
644	Mile (Kilometer)	Lane Line, ___ inch (___ mm)

644	Mile (Kilometer)	Center Line
644	Mile (Kilometer)	Channelizing Line, ___ inch (___ mm)
644	Foot (Meter)	Stop Line
644	Foot (Meter)	Yield Line
644	Foot (Meter)	Crosswalk Line
644	Foot (Meter)	Transverse/Diagonal Line
644	Each	Handicap Symbol Marking
644	Each	Railroad Symbol Marking, ___ inch (___ mm)
644	Each	School Symbol Marking, __ inch (___ mm)
644	Each	Bicycle Lane Marking Sym_bol
644	Each	Shared Lane Marking
644	Foot (Meter)	Parking Lot Stall Marking
644	Each	Lane Arrow
644	Each	Word on Pavement, ___ inch (___ mm)
644	Foot (Meter)	Dotted Line, ___ inch (___ mm)
644	Foot or Square Foot (Meter or Square Meter), or Each	Removal of Pavement Marking
644	Lump Sum	Two-Way Radio Equipment

ITEM 645 PREFORMED PAVEMENT MARKING

645.01 Description. This work consists of furnishing and applying preformed pavement marking material according to Item 641, 740.01, 740.05, 740.06, and the additional requirements specified below.

645.02 Materials. Furnish materials conforming to the following:

Type A (permanent markings),
Type A1, A2, or A3 ..... 740.05
Type B (work zone markings),
Type II (non-removable) 740.06
Type C (work zone markings),
Type I (removable) 740.06

Do not apply materials that has exceeded the manufacturer's shelf life.

645.03 Application. Only apply on clean dry pavement surfaces. If there is oil, salt or dust; power wash the pavement and allow the pavement to dry.

Furnish the Engineer with the manufacturer's application instructions. Record the surface temperature and date of application. Furnish documentation to the Engineer. Apply preformed markings to the pavement by means of a precoated adhesive on the back, or by an adhesive or activator furnished with the markings and used according to the manufacturer's recommendations. Form lines 12 inches (300 mm) wide or less by one piece; form lines wider than 12 inches (300 mm) by no more

than two pieces. Do not overlap individual pieces. Do not allow a gap greater than 1/4 inch (6 mm) between pieces.

Do not use preformed markings that are subject to premature adhesion or contamination before placement.

Apply preformed markings according to the appropriate type of application as follows:

A. Type A Marking Application. Apply the preformed markings while the pavement surface temperature is at the manufacturer's application recommendations. Before any application, test and record the pavement surface temperature, air temperature and dew point. Retest and record every 4 hours of operation. Demonstrate to the Engineer the testing devices are accurate and operational. Initially position the marking under light pressure, or use a hand operated light roller or mechanical applicator. Once correctly located, hold the marking in position without delay by rolling.

If Type A preformed markings are specified to be inlaid on newly placed asphalt concrete, press the markings into the warm surface using a mechanical roller. Proper application of inlaid markings requires that the asphalt concrete pavement surface have a temperature below the maximum temperature recommended for the preformed material or its adhesive backing.

B. Type B and Type C Marking Application. Apply the preformed markings according to the manufacturer's recommendations.

645.04 Layout and Premarking. In addition to the requirements specified in 641.06, place preformed auxiliary markings only on new pavement.

645.05 Basis of Payment. The Department will not pay for under thickness lines or non-specification materials. The Department will pay for accepted quantities at the contract prices, or prices adjusted according to 641.11, measured according to 641.12, with the provisions specified in 641.13, and as follows:

Item	Unit	Description
645	Mile (Kilometer)	Edge Line, ___ inch (___ mm), Type ___
645	Mile (Kilometer)	Lane Line, ___ inch (___ mm), Type ___
645	Mile (Kilometer)	Center Line, Type ___
645	Foot (Meter)	Channelizing Line, ___ inch (___ mm), Type ___
645	Foot (Meter)	Stop Line, Type ___
645	Foot (Meter)	Yield Line, Type____
645	Foot (Meter)	Crosswalk Line, Type ___
645	Foot (Meter)	Transverse/Diagonal Line, Type ___
645	Each	Handicap Symbol Marking, Type ___
645	Each	Railroad Symbol Marking, Type ___
645	Each	School Symbol Marking, ___ inch (___ mm), Type ___
645	Each	Bicycle Lane Symbol Marking, Type___
645	Each	Shared Lane Marking
645	Foot (Meter)	Parking Lot Stall Marking, Type ___
645	Each	Lane Arrow, Type ___

645	Each	Word on Pavement, ___ inch (___ mm), Type ___
645	Foot (Meter)	Dotted Line, ___ inch (___ mm), Type ___
645	Foot, Square Foot (Meter, Square Meter), or Each	Removal of Pavement Marking
645	Lump Sum	Two-Way Radio Equipment

ITEM 646 EPOXY PAVEMENT MARKING

646.01 Description. This work consists of furnishing and applying epoxy pavement markings according to Item 641, 740.01, 740.07, 740.09, and the additional requirements specified below.

Store and handle epoxy material according to all the applicable EPA and local environmental regulations and the manufacturer's recommendations.

646.02 Materials. Furnish materials conforming to:

Epoxy pavement markings 740.07
Glass beads, Type D..... 740.09

The Engineer may obtain random samples from the application equipment in accordance with supplement 1089.

Furnish the manufacturer's identification information for the sampled liquid materials. The Department will test the quality assurance sample for conformance to the manufacturer's production ranges. Samples not meeting the manufacturer's production ranges will require the Contractor to re-apply, at his expense, any markings using that sample. All other untested batches will become not approved materials and will either require testing or re-application.

Do not apply material that has exceeded the manufacturer's shelf life. Do not use glass beads that are wet.

646.03 Equipment.

A. General. Equip all striping equipment for center line, lane line and edge line markings with a computerized Data Logging System (DLS) conforming to 641.04 when the length of marking exceeds 0.5 miles (0.8 km) of continuous line equivalent.

Furnish written documentation to the Engineer for the equipment's operational capabilities from the equipment manufacturer.

Use equipment to apply epoxy pavement markings that has the following capabilities and features:

1. Capable of mixing the epoxy components in proportions recommended by the manufacturer and applying glass beads simultaneously with line placement.

2. Capable of applying epoxy at the specified thickness, width, and pattern.

3. Individual material reservoirs, or space, for the storage of Part A and Part B of the epoxy.

4. Heating equipment of sufficient capacity to maintain the epoxy components at the manufacturer's recommended temperature, and to produce the required amount of heat at the mixing head and gun tip and maintain those temperatures with the tolerances recommended by the epoxy manufacturer for the spray application.

5. Adequate individual tanks for the storage and dispensing of Size I and Size II glass beads.

6. Individual dispensers for the simultaneous application of Size I and Size II glass beads at specified rates.

7. Individual metering devices on the proportioning pumps (one indicator per pump) and stroke counters to monitor gallon (liter) usage. Ensure that these devices are clearly visible.

8. All the necessary spray equipment mixers, compressors, and other appurtenances to allow for the placement of reflectorized pavement marking systems in a simultaneous sequence of operations.

9. A minimum 24 inch (600 mm) long static mixer unit or an equivalent system that produces properly mixed material.

10. A completely enclosed flush and purge system to clean the lines and the guns without expelling any of the solution into the environment.

B. Long Line Equipment. Furnish a striper to apply long line epoxy markings that is:

1. Truck-mounted and self-contained.

2. Designed to spray the epoxy and glass beads in continuous and skip line.

3. Maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.

C. Auxiliary Marking Equipment. Furnish application equipment for auxiliary markings by either of the following two methods:

1. Equip the striper with accessories for applying auxiliary markings.

2. Use a portable applicator approved by the Engineer.

D. Documentation Requirements Furnish the Engineer documentation from the manufacturer that the equipment meets all requirements of 646.03. Demonstrate the equipment has the capability to obtain the manufacturer's required temperature for the mixed components and the required temperature at the lines and gun.

646.04 Cleaning and Surface Preparation.

A. General. Before applying epoxy, clean and prepare the pavement surface in the following sequence:

1. Remove all debris, oil, and any other contaminants that may hinder the adhesion of the epoxy to the pavement.

2. Use a power-broom to clean the pavement.

3. Remove residue and debris with blasts of compressed air.

4. Follow any additional manufacturer's recommendations for surface preparation.

Perform operations in such a manner that the finished pavement surface is not damaged or unnecessarily scarred or left in a pattern that will mislead or misdirect the motorist and that minimizes airborne dust. Avoid damage to transverse and longitudinal joint sealers.

B. Asphalt Concrete Pavements. In addition to the requirements of 646.04.A, the following apply.

Wait 48 hours after the placement of polymer modified asphalt-concrete pavement before preparing it for epoxy pavement markings.

For any other type of modified asphalt or for open graded friction course asphalts, contact the manufacturer for surface preparation recommendations. Furnish the Engineer copies of the manufacturer's recommendations.

Lightly abrade any new asphalt concrete pavement containing SBS, SBR latex or SMA latex polymer modifiers without scarring the area between the broken lines to the manufacturer's recommendations to remove polymer surface film to assure proper bonding. In no case shall the removal of the polymer surface film be less than that required for the epoxy to properly bond and adhere.

C. Portland Cement Concrete Pavements. On new portland cement concrete pavements, do not begin cleaning operations until a minimum of 30 days after the placement of concrete, unless otherwise directed by the Engineer. In addition to the requirements of 646.04.A, the following apply.

Remove all curing compound and laitance on the concrete surface and in any textured pavement valleys.

Round the profiles of the peaks of textured pavement and remove sharp edges and irregularities.

Acceptable removal methods are:

1. Sand blasting with containment.

2. Lightly abrading the surface without scarring the surrounding surface. This must be demonstrated before the application and approved by the Engineer.

3. Blast track cleaning.

4. High-pressure water blasting (greater than 5000 psi [34 450 kPa]) with or without abrasives and with sufficient time to allow the pavement to dry before applying epoxy markings.

5. Other methods approved by the Engineer.

Contain and dispose of all the removal debris.

D. Removal of Existing Markings. When placing epoxy markings in the same place as existing pavement markings, remove at least 95 percent of the existing pavement markings. Use a removal method that results in little or no color and texture changes in the surrounding pavement.

E. Preparation Area.

1. Lines. Prepare an area that is the width of the new pavement marking, or existing line, plus 1 inch (25 mm) on each side and the length of broken lines plus 12 inches (300 mm) on each end.

2. Arrows, Letters, and Symbols. When cleaning for letters and symbols, prepare an area that is sufficiently large to accommodate the new marking, or to remove the existing marking.

646.05 Application. Apply epoxy only when the surface is clean and dry and when the pavement and air temperature are above 50 ºF (10 ºC). Transfer the entire contents of each material container to the striper tanks. Keep the epoxy thoroughly mixed at all times during application. Before any application, test and record the pavement surface temperature, air temperature. Retest and record every 4 hours of operation. Demonstrate to the Engineer the testing devices including DLS are accurate and operational.

Apply epoxy uniformly to the surface to be marked at a rate specified below. To achieve the rate, ensure that the thickness of the applied epoxy is 20 mils (0.51 mm).

20 Mil Thickness	Line Width (inch)				
	4	6	8	12	24
	Gallon per Mile of Line				
Solid Line	22	33	44	66	132
Broken Line	5.5	8.25	11	16.5	33
Dotted Line	5.5	8.25	11	16.5	33
Areas, Symbols, Words	1.25 gallon per 100 square feet				

0.51 mm Thickness	Line Width (mm)				
	100	150	200	300	600
	Liter per Kilometer of Line				
Solid Line	50	75	100	150	300
Broken Line	12.5	19	25	38	75
Dotted Line	12.5	19	25	38	75
Areas, Symbols, Words	0.51 L/m^2				

Do not dilute the epoxy.

Apply enough glass beads to the uncured epoxy so that the beads completely fill the epoxy film from the film-pavement interface to the top surface of the film to the extent that there are loose beads on the surface of the uncured line. Apply glass beads at a minimum rate of 31 pounds per 100 square feet (15 kg per 10 m^2) of epoxy to achieve uniform retroreflectivity. Drop glass beads onto the epoxy in a double-drop system with the large gradation (Size I) first and the regular gradation (Size II)

second in the same pass of the equipment. Apply the beads in equal amounts by weight.

Cease operations when any of the following conditions are observed:

A. The marking does not consistently dry to a no-track condition.

B. The marking has cyclical soft spots.

Resume marking operations when the Inspector is satisfied the problem is corrected.

Replace unsatisfactory markings according to 641.11.

Furnish the Engineer daily, biweekly and final DLS reports according to 641.04.

646.07 Basis of Payment. The cost of cleaning and surface preparation according to 646.04 is included in the unit bid cost for the various pavement markings.

The Department will make payment for accepted quantities at the contract prices, or prices adjusted according to 641.11, measured according to 641.12, with the provisions specified in 641.13, and as follows:

Item	Unit	Description
646	Mile (Kilometer)	Edge Line, ___ inch (___ mm)
646	Mile (Kilometer)	Lane Line, ___ inch (___ mm)
646	Mile (Kilometer)	Center Line
646	Foot (Meter)	Channelizing Line, ___ inch (___ mm)
646	Foot (Meter)	Stop Line
646	Foot (Meter)	Yield Line
646	Foot (Meter)	Crosswalk Line
646	Foot (Meter)	Transverse/Diagonal Line
646	Foot (Meter)	Curb Marking
646	Square Foot (Square Meter)	Island Marking
646	Each	Handicap Symbol Marking
646	Each	Railroad Symbol Marking
646	Each	School Symbol Marking, ___ inch (___ mm)
646	Each	Bicycle Lane Symbol Marking
646	Each	Shared Lane Marking
646	Foot (Meter)	Parking Lot Stall Marking
646	Each	Lane Arrow
646	Each	Word on Pavement, ___ inch (___ mm)
646	Foot	Dotted Line, ___ inch (___ mm)
646	Each, Foot, (Meter) Square Foot (Square Meter)	Removal of Pavement Marking
646	Lump Sum	Two-Way Radio Equipment

ITEM 647 HEAT-FUSED PREFORMED THERMOPLASTIC PAVEMENT MARKING

647.01 Description. This work consists of furnishing and applying heat-fused preformed thermoplastic for use as auxiliary pavement markings according to Item 641, 740.01, 740.08, 740.09 and the additional requirements specified below.

647.02 Materials. Furnish materials conforming to:

Heat fused preformed thermoplastic
pavement marking material..... 740.08
Glass beads, Type E..... 740.09

647.03 Equipment. Use manufacturer recommended equipment to apply the heat-fused preformed thermoplastic pavement marking material according to the appropriate type, as follows:

A. Type A90 or Type A125 Material.

1. Propane torch to heat the pavement and material according to 647.04.B.

2. Infrared thermometer to assure that both the pavement and the material are properly heated and do not exceed the manufacturer's specified application temperature.

B. Type B90 or Type B125 Material.

1. Propane torch for ensuring no moisture is present on the pavement and heating the material according to 647.04.C.

2. A thermometer is not required.

647.04 Application.

A. General. Apply the heat-fused preformed thermoplastic pavement marking material to clean, dry pavement surfaces according to the appropriate type unless otherwise directed by the manufacturer's recommendation. Apply primer sealer on portland cement concrete pavements for proper adhesion only if the manufacturer requires its use.

Form lines 12 inches (300 mm) wide or less by one piece; form lines wider than 12 inches (300 mm) by no more than two pieces. Do not overlap individual pieces. Do not allow a gap greater than 1/4 inch (6 mm) between pieces.

B. Type A90 and Type A125 Material Application on Asphalt Concrete and Portland Cement Concrete Pavements. Uniformly pre-heat the pavement to 300 °F (149 °C) with a propane torch. Place the material on the warm surface as soon as practical, then uniformly post-heat to 400 °F (204 °C). Begin the post-heating process of material application as quickly as possible. The Contractor may have to

extend post-heating on concrete having a high moisture content. Allow the material to cool naturally and solidify before exposing it to traffic.

Type A90 and A125 materials shall contain intermix beads throughout. Drop-on glass beads are required.

C. Type B90 and Type B125 Material Application on Asphalt Concrete and Portland Cement Concrete Pavements. Heat the pavement only to ensure no moisture is present. Place the material on the dry surface and then uniformly heat the material until it bubbles and changes color to off-white. Material must be able to be applied with no preheating of the pavement to a specified temperature and without the use of a thermometer. Allow the material to cool naturally and solidify before exposing it to traffic.

Type B90 and B125 material shall contain intermix glass beads throughout. Drop-on glass beads are required.

647.05 Basis of Payment. The Department will pay for accepted quantities at the contract prices, or prices adjusted according to 641.11, measured according to 641.12, with the provisions specified in 641.13, and as follows:

Item	Unit	Description
647	Foot (Meter)	Channelizing Line, ___ inch (___ mm), Type ___
647	Foot (Meter)	Stop Line, Type ___
647	Foot (Meter)	Yield Line, Type____
647	Foot (Meter)	Crosswalk Line, Type ___
647	Foot (Meter)	Transverse/Diagonal Line, Type ____
647	Each	Handicap Symbol Marking, Type ___
647	Each	Railroad Symbol Marking, Type ___
647	Each	School Symbol Marking, ___ inch (___ mm), Type ___
647	Each	Bicycle Lane Symbol Marking, Type____
647	Each	Shared Lane Marking
647	Each	Speed Measurement Marking
647	Foot (Meter)	Parking Lot Stall Marking, Type ___
647	Each	Lane Arrow, Type ___
647	Each	Word on a Pavement, ___ inch (___ mm), Type ___
647	Foot (Meter)	Dotted Line, ___ inch (___ mm), Type ___
647	Each, Foot, Square Foot (Meter, Square Meter)	Removal of Pavement Marking

ITEM 648 SPRAY THERMOPLASTIC PAVEMENT MARKING

648.01 Description
648.02 Materials
648.03 Equipment

648.04 Surface Preparation
648.05 Application
648.06 Basis of Payment

648.01 Description. This work consists of furnishing and applying spray thermoplastic pavement markings according to Item 641, 740.01, 740.09, 740.10, and the additional requirements specified below.

648.02 Materials. Furnish materials conforming to:

Spray Thermoplastic Pavement Marking.....	740.10
Glass beads, Type C	740.09

The Engineer may obtain random samples from the application equipment in accordance with supplement 1089. Furnish the manufacturer's identification information for the sampled materials. The Department will test the quality assurance sample for conformance to the manufacturer's production ranges. Samples not meeting the manufacturer's production ranges will require the Contractor to re-apply, at his expense, any markings using that sample. All other untested batches will become not approved materials and will either require testing or re-application.

Do not apply material that has exceeded the manufacturer's shelf life. Do not use glass beads that are wet.

648.03 Equipment. Equip all striping equipment for center line, lane line and edge line markings with a computerized Data Logging System (DLS) conforming to 641.04 when the length of marking exceeds 0.5 mile (0.8 km) of continuous line equivalent.

Ensure that the application equipment applies lines with a square end and can apply broken lines. Furnish application equipment for applying spray thermoplastic markings that produces different widths of lines.

Use equipment that ensures uniformity in the thickness and width of lines. Use equipment that forms lines 8 inches (200 mm) wide or less by one application pass.

648.04 Surface Preparation. Before applying spray thermoplastic the pavement surfaces must be clean, dust free, and completely dry.

Apply spray thermoplastic to new pavement, over existing thermoplastic, or over one application of paint. Do not apply spray thermoplastic over epoxy, polyester, or preformed markings. Remove poorly adhering, flaking and loose markings and curing compounds. Use an air blast, or manual or mechanical broom to prepare surfaces. When more effort is needed to obtain a surface free from adhering, flaking and loose markings and curing compounds, use water blasting or mechanical removal.

648.05 Application. If applying spray thermoplastic to pavements that are less than six months old, ensure that both the pavement surface and the ambient air temperature at the time of application are not less than 50 °F (10 °C) and rising.

However, if applying spray thermoplastic to pavements that are older than six months, ensure that both the pavement surface and the ambient air temperature at the time of application are not less than 70 °F (21 °C) and rising. Ensure that the temperature of spray thermoplastic at the point of application is at least 375 °F (191 °C) and not more than 425 °F (218 °C).

Apply spray thermoplastic at a thickness of 45 mil (1.15 mm) at the following rates:

45 Mil Thickness	**Line width (inch)**			
	4	6	8	12
	Pounds per Mile of Line			
Solid Line	762-886	1143-1329	1524-1772	2286-2658
Broken or Dotted Line	191-222	286-332	381-443	572-666

1.15 mm Thickness	**Line Width (mm)**			
	100	150	200	300
	Kilogram per Kilometer of Line			
Solid Line	209-242	313-364	417-485	626-728
Broken or Dotted Line	52-61	79-92	104-121	158-184

Mechanically apply glass beads to the wet spray thermoplastic surface so that the beads are embedded and retained and provide uniform retroreflectivity in the surface. Apply beads at a minimum rate of 10 pounds per 100 square feet (4.9 kg per 10 m^2) of spray thermoplastic surface area.

Use primer when required by the manufacturer. Apply primer according to the manufacturer's recommendations.

For each route section on the DLS report, the Engineer will compute the amount of spray thermoplastic marking material and glass beads applied. The Department will reduce the contract price in direct proportion to the percent of deficiency of spray thermoplastic marking material or glass beads as specified in 648.05, up to 20 percent for each material deficiency. The Department will only use the greater deficiency of marking material or glass beads to compute the deduction.

The Department will consider materials unsatisfactory if at least one of the following conditions is met:

A. Deficiency of spray thermoplastic marking material or glass beads is 20 percent or more.

B. Materials applied outside the temperature or application requirements in 648.05 without written approval of the Engineer.

C. Markings not meeting the performance parameters contained in Supplement 1047, Appendices C, D, E, and G.

1. Numerical rating of 8 or lower for Daytime Color (Appendix C)
2. Composite rating of 8 or lower for Night Visibility (Appendix D)
3. Numerical rating of 9 or lower for Durability (Appendix E)

4. Less than the initial measurement for Retroreflectivity (Appendix G)

Replace or reapply spray thermoplastic markings and glass beads in all sections determined to be unsatisfactory.

Furnish the Engineer daily, biweekly and final DLS reports conforming to 648.03, and additional reports indicating material type and quantities in pounds (kilograms) of spray thermoplastic materials used, as per 641.04.

648.06 Basis of Payment. The Department will not pay for any spray thermoplastic lines that do not meet the required thickness. The Department will pay for accepted quantities at the contract prices, or prices adjusted according to 648.05, measured according to 641.12, with the provisions specified in 641.13, and as follows:

Item	Unit	Description
648	Mile (Kilometer)	Edge Line, ___ inch (___ mm)
648	Mile (Kilometer)	Lane Line, ___ inch (___ mm)
648	Mile (Kilometer)	Center Line
648	Foot (Meter)	Channelizing Line, ___ inch (___ mm)
648	Foot (Meter)	Dotted Line, ___ inch (___ mm)
648	Foot or Square Foot (Meter or Square Meter), or Each	Removal of Pavement Marking
648	Lump Sum	Two-Way Radio Equipment

650 ROADSIDES

ITEM 651 TOPSOIL STOCKPILED

651.01 Description. This work consists of stripping topsoil from areas shown on the plans or from within the Right-of-Way limits, transporting, and stockpiling topsoil at locations shown on the plans or at locations selected by the Contractor with project approval.

651.02 Construction Requirements. Remove all heavy grass, weeds, or other vegetation over the areas before stripping. Keep the topsoil separate from other excavated materials. Remove topsoil before beginning the regular excavation or embankment work in the area. Strip the topsoil to the depth shown on the plans or as directed by the Engineer.

651.03 Method of Measurement. The Department will measure Topsoil Stockpiled by the number of cubic yards completed and accepted, measured from the removal areas.

651.04 Basis of Payment. The Department will not pay for any removal of topsoil beyond the directed depth.

The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
651	Cubic Yard	Topsoil Stockpiled

ITEM 652 PLACING STOCKPILED TOPSOIL

652.01 Description. This work consists of hauling and spreading topsoil from stockpiles and preparing the surface.

652.02 Construction Requirements. Prepare the surface according to 653.03. Place and spread the topsoil according to 653.03.

652.03 Method of Measurement. The Department will measure Placing Stockpiled Topsoil by the number of cubic yards completed and accepted in place.

652.04 Basis of Payment. The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
652	Cubic Yard	Placing Stockpiled Topsoil

ITEM 653 TOPSOIL FURNISHED AND PLACED

653.01 Description
653.02 Materials
653.03 Construction Requirements
653.04 Method of Measurement
653.05 Basis of Payment

653.01 Description. This work consists of furnishing and spreading topsoil and preparing the subgrade.

653.02 Materials. Furnish topsoil consisting of loose, friable, loamy material without admixture of subsoil or refuse. For topsoil to be considered loamy, ensure that the fraction passing the No. 10 (2.00 mm) sieve does not contain more than 40 percent clay. Furnish topsoil consisting of not less than 4 percent and not more than 20 percent organic matter as determined by loss on ignition of samples oven dried to constant weight at 212 °F. Test topsoil according to AASHTO T 267. Furnish topsoil that is free of grass, brush, and, roots.

653.03 Construction Requirements. Before placing any topsoil, prepare all areas to be covered with topsoil according to 659.10. Place the topsoil according to 659.11. When seeding is specified, open the topsoil up to receive the seed.

653.04 Method of Measurement. The Department will measure compacted Topsoil Furnished and Placed by the number of cubic yards accepted in place.

653.05 Basis of Payment. The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
653	Cubic Yard	Topsoil Furnished and Placed

ITEM 654 RENOVATING EXISTING SOIL

654.01 Description
654.02 Materials
654.03 Construction Requirements
654.04 Method of Measurement
654.05 Basis of Payment

654.01 Description. This work consists of preparing a suitable seedbed by grading and renovating existing soil, and furnishing and placing commercial fertilizer, if specified.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

654.02 Materials. Use commercial fertilizer conforming to 659.04.

654.03 Construction Requirements. Prepare the surface area for seed according to 659.10.

If the Contract Documents require commercial fertilizer, place it according to 659.04.

654.04 Method of Measurement. The Department will measure Renovating Existing Soil by the number of M square feet completed and accepted.

The Department will measure Commercial Fertilizer by the number of tons completed and accepted.

654.05 Basis of Payment. The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
654	M Square Feet	Renovating Existing Soil
654	Ton	Commercial Fertilizer

ITEM 656 ROADSIDE CLEANUP

656.01 Description. This work consists of cleaning up outside the excavated and filled areas and disposing of undesirable plants and other vegetative growth, prunings, rubbish, stumps, conspicuous stones, all down timber, dead brush, logs and timbers; felling and destroying of all snags and such dangerous trees; and pruning trees, native shrubs and similar vegetation but does not include work to be performed under Item 201.

656.02 Intensity of Cleanup. Control the intensity of cleanup to effect a natural transition in cleanup treatment from the edge of the pavement outward to the limits of the Right-of-Way to avoid sharp demarcation between the artificial and the natural.

656.03 Cleaning. After removal of large objects, clean the designated areas with grubbing rakes or wide-spaced tooth rakes. Do not disturb or injure desirable grass, vines, or wild flowers.

656.04 Pruning. Prune trees 6 inches (150 mm) or less in diameter and native shrubs and similar vegetation according to Item 666. Consider the diameter of existing trees to be the diameter measured at 54 inches (1.4 m) above the ground.

656.05 Disposal of Refuse. Use removed materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

656.06 Method of Measurement. The Department will measure Roadside Cleanup by the number of M square feet (square meters) cleaned up and accepted.

The Department will determine the boundaries of the area to be cleaned up and the number of units.

656.07 Basis of Payment. The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
656	M Square Feet (Square Meter)	Roadside Cleanup

ITEM 657 RIPRAP FOR TREE PROTECTION

657.01 Description. This work consists of furnishing and placing riprap for protecting selected trees or shrubs by tree wells and retaining walls.

657.02 Materials. Furnish stone consisting of sandstone, limestone, or other natural rock with a maximum 30 percent single slab loss and a maximum 20 percent cumulative loss after testing to ASTM D 5240. Use an 8-inch slab test sample. The Department may waive testing when the stone source has a known durability history. Furnish embankment according to Item 203. Unless otherwise specified, use 4-inch (100 mm) pipe conforming to 611 Type E conduits.

657.03 Tree Wells in Fill. Where a fill around a tree or shrub not marked for removal will be 12 inches (0.3 m) or more in depth over the feeding root area or ground surface lying within the periphery of the tree, construct a dry hand-laid stone riprap tree well. Construct a wall, of the same height as the fill, circling the tree or shrub and 3 1/2 feet (1 m) from the tree trunk or as specified. Construct the wall so that the top of the wall follows the contour on the finished grade in a neat line.

Construct tree wells before placing the fill over the root area. However, the Contractor may bring up the fill with the wall after required aggregate for root aeration is in place according to Item 658.

657.04 Walls in Cut. Where the top of the slope in cut is within 6 feet (2 m) of the trunk of a tree not marked for removal, construct a dry hand-laid stone riprap wall. Toe the bottom of the wall into the ground 2 inches (50 mm) unless otherwise shown on the plans, and make the top of the wall even with the original ground line at the base of the tree. Extend the length of the wall far enough from the tree to amply cover the roots, or according to the shape and size as shown on the plans. Flare the ends of the wall back, and taper or fade them out into the finished grade of the slope in a neat line.

657.05 Hand-Laid Stone Riprap. Construct the earth bed on which riprap is to be placed to a slope of 1 foot (300 mm) vertical to 2 inches (50 mm) horizontal. Dress the earth bed to a true plane. Where riprap is to rest against a fill, tamp the embankment against the back of the stone.

Construct riprap for walls or wells according to the arrangements and dimensions shown on the plans. Lay each course with the long dimensions of each stone perpendicular to the slope or batter.

Use individual stones that are roughly rectangular in cross-section and are a minimum of 3 inches (75 mm) in the vertical depth with a horizontal dimension of not less than 15 inches (0.4 m). Place the individual stones by hand, one upon the other so that they break joints with the stone in the course below. Where it is necessary to use more than one stone to provide the specified thickness or depth of the wall, thereby resulting in joints parallel to the face of the wall, place such stones to break joints with the adjacent stones.

Fill the space between the larger stones with spalls rammed into place. Ensure that the surface of the finished riprap does not vary more than 3 inches (75 mm) from that shown on the plans, and that it presents an even, tight surface, pleasing in appearance.

657.06 Earthwork. Perform excavation and embankment, as necessary, according to Item 203.

657.07 Pipe Drains. Drain tree wells with pipe starting on the original ground surface and lay to drain beyond the toe of the fill. Install pipe for drains according to Item 611.

657.08 Method of Measurement. The Department will measure Riprap for Tree Protection by the number of square yards (square meters) in place, completed and accepted. The Department will measure parallel to the face of the wells or walls.

657.09 Basis of Payment. The Department will pay for embankment and excavation under Item 203 and the pipe for drains under Item 611.

The Department will pay for accepted quantities at the contract price for as follows:

Item	Unit	Description
657	Square Yard (Square Meter)	Riprap for Tree Protection

ITEM 658 TREE ROOT AERATION

658.01 Description. This work consists of furnishing and placing the necessary aggregate and tile for the protection and aeration of the roots of trees and shrubs.

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.17.

658.02 Materials. Furnish aggregate for tree root aeration and protection consisting of No. 4 or 467 limestone or gravel with a maximum sodium soundness loss of 15 percent.

Furnish 4 inch (100 mm) pipe conforming to 611 Type E conduit. Furnish embankment conforming to Item 203.

658.03 Preparation. The feeding root area to be protected and aerated is the ground surface area lying within the periphery of the tree or shrub not marked for removal. Prepare these areas by excavating all vegetation, wood, brush, and debris.

658.04 Aeration for Trees Not Welled. Where the earth fill is less than 12 inches (300 mm) and more than 4 inches (100 mm) over the feeding root area, loosely spread an aggregate aeration course of one-half the height of fill, but not less than 3 inches (75 mm), over this area. At the tree trunk, increase the thickness to the height of the fill and extend it outward from the tree trunk in collar form for a distance of 15 inches (0.4 m). Place a 2-inch (50 mm) layer of straw or hay over the aggregate.

658.05 Aeration with Tree Wells. Place an aeration course of aggregate while constructing the tree wells and before any other filling. Do not place any aggregate inside the tree well (between the wall and the tree trunk). Place the aggregate over the entire feeding root area outside of the tree wells to a total depth of 6 inches (150 mm) for each 12 inches (300 mm) of earth fill, or proportion thereof, but place a minimum depth of 6 inches (150 mm) regardless of depth of overlying fill. Place a 2-inch (50 mm) layer of straw or hay over the aeration layer.

658.06 Earth Embankment. Perform excavation and embankment, as necessary, according to Item 203.

658.07 Method of Measurement. The Department will measure Tree Root Aeration by the number of cubic yards (cubic meters), measured in the carrier or truck according to 109, of the aggregate furnished, placed, completed, and accepted.

658.08 Basis of Payment. The Department will pay for embankment and excavation under Item 203 and the pipe under Item 611.

The Department will pay for accepted quantities at the contract price as follows:

Item	Unit	Description
658	Cubic Yard (Cubic Meter)	Tree Root Aeration

ITEM 659 SEEDING AND MULCHING

659.01 Description. This work consists of placing topsoil, preparing the seed bed, and placing and incorporating seed, agricultural lime, commercial fertilizer, and placing mulching material used to achieve NPDES final stabilization.

Perform this work in areas shown on the plans for seeding and mulching.

Perform seeding and mulching after completing all work in the area and within 7 days of obtaining final grade. If it is anticipated that future work may disturb an area, place temporary NPDES compliant Best Management Practices as needed until final stabilization measures under this item can be installed. If the Contractor disturbs a final area, then the Contractor shall restore this area. With the Engineer's approval, the Contractor may apply permanent seed between October 30 and March 1 on projects started and completed within the same calendar year.

Use all excavation material in the work. Alternatively legally use, recycle, or dispose of all excavated materials according to 105.16 and 105.17.

659.02 Testing of Soil or Topsoil. When a Soil Analysis Test of the soil or topsoil is required in the plans, use the following sampling frequency to determine the lime required:

A. When an area is near final grade, perform Standard Soil Analysis Test to measure the soil acidity or alkalinity (pH) if no topsoil is to be placed. This testing will determine the soil requirements for lime. If the soil requirements are different than the standard lime mixture ratio application rates then the standard application rate shall be adjusted up or down such that the soil requirements are met. If liquid lime is used then use the following application table to achieve a pH of 6.5 or greater. Calculate the difference between the soil pH and 6.5 pH.

pH Difference	0.25	0.50	0.75	1.0
Application rate in gals/ac (L/ha)	2.5 (4)	5 (8)	10 (15)	20 (30)

Example: Soil Analysis Test pH=5.75 required pH=6.5 difference= 0.75 required application rate is 10 gals/ac (15L/ha)

Only use liquid lime on the QPL list. Provide the Engineer with the Liquid Lime manufacturers written application rate. The Engineer will only accept printed application rates.

There will be no change in the mixture ratio. The sampling frequency is one sample every 10 acres (4.0 ha) per project side or one sample per project side whichever is greater. A sample consist of 15 soil cores in a random pattern spaced at a minimum of 500 feet (153 m) apart. Sample any change in soil. Soil changes can be seen as color and/or texture changes.

B. If placing topsoil, perform the Standard Soil Analysis Test from topsoil stockpiles to measure the topsoil acidity or alkalinity (pH). This testing will determine the soil requirements for lime. If the topsoil requirements are different than the standard lime mixture ratio application rates then the standard application rate shall be adjusted up or down such that the topsoil requirements are met.

If liquid lime is used then use the following application table to achieve a pH of 6.5 or greater. Calculate the difference between the soil pH and 6.5 pH.

pH Difference	0.25	0.50	0.75	1.0
Application rate in gals/ac (L/ha)	2.5 (4)	5 (8)	10 (15)	20 (30)

Example: Soil Analysis Test pH=5.75 required pH=6.5 difference= 0.75 required application rate is 10 gals/ac (15L/ha)

Only use liquid lime on the QPL list. Provide the Engineer with the Liquid Lime manufacturers written application rate. The Engineer will only accept printed application rates.

There will be no change in the mixture ratio. The sampling frequency is one sample every 10,000 cubic yards (7600 m^3) of a topsoil stockpile, or at least two samples per stock pile whichever is greater. Test each stockpile. A sample consisting of 15 soil cores in a random pattern spaced evenly throughout the stockpile.

Mix the 15 cores from each sample and then remove 1 pint (0.5 L) for testing.

The Ohio County Extension offices can provide the Contractor with a soil sample kit and testing laboratory locations.

The Department will review the sample test results and approve application rates for the standard mixture ratios provided by the Contractor.

If a Soil Analysis Test of the soil is not required by the plans, use the standard application rates for lime and commercial fertilizer.

659.03 Lime. Obtain granular or liquid lime from a agricultural lime dealer or manufacturer whose brands are grades registered or licensed by the State of Ohio, Department of Agriculture. The granular or liquid lime standard grade is Ag-ground 90+. Ag-ground 90+ is defined as agricultural ground limestone, having a total neutralizing power (TNP) of 90 percent or more, at least 40 percent passing a No. 100 (150 μm) sieve and 95 percent passing a No. 8 (2.36 mm) sieve. Test granular or liquid lime according to Supplement 1007. Apply the granular or liquid lime standard grade Ag-ground 90+ at the standard application rate of 92 pounds per 1000 square feet (2 tons per acre) [0.45 kg/m^2 (9 metric tons/ha)].

The Contractor may provide other lime grade materials. The lime grade materials provided will meet Table 7-10 "Equivalent Amounts of Liming Materials" found in Bulletin 472, *Ohio Agronomy Guide*, published by the Cooperative Extension Service, The Ohio State University. Based on the type of lime grade material provided, determine the increase or decrease in the standard application rate from Table 7-10 "Equivalent Amounts of Liming Materials" found in Bulletin 472, "Ohio Agronomy Guide", published by the Cooperative Extension Service, The Ohio State University.

If using liquid lime apply liquid lime at a rate of 5 gals/acre (8 L/ha) unless otherwise required per the soil or topsoil Soil Analysis Test. Provide the Engineer with the Liquid Lime manufacturers written application rate. The Engineer will only accept printed application rates. Only use Liquid lime on the QPL list.

If testing of the soil or topsoil was performed, the lime required will be such that a growing environment of slightly acidic (pH 6.5) can be reached. The application rate of the standard grade lime Ag-ground 90+ will be adjusted up or down to achieve this condition and reported to the Department for approval. No lime is required for the soil or topsoil if the test shows a slightly acidic condition.

659.04 Commercial Fertilizer. Obtain commercial fertilizer from a dealer or manufacturer whose brands are grades registered or licensed by the State of Ohio, Department of Agriculture.

Commercial fertilizer may be dry or liquid. Apply standard commercial fertilizer 10-20-10 evenly over the surface at a standard dry application rate of 20 pounds per 1000 square feet (0.1 kg/m^2). Furnish liquid application rates for approval by the Department.

The Contractor may provide other commercial fertilizer mixture ratios, however, ensure that the ratio meets or exceeds the standard commercial fertilizer ratio of 10-20-10 by providing an application rate specific for that ratio. The Department will approve this application rate that is specific to that ratio provided by the Contractor.

For areas of inter-seeding apply commercial fertilizer 12-12-12 over the affected area at the above rate.

For commercial fertilizer second application the method, mixture, and rate is broadcast 12-12-12 evenly over the surface without incorporation into the soil at a rate of 10 pounds per 1000 square feet (0.05 kg/m^2).

659.05 Topsoil. If placing topsoil as specified in the plan, then stockpile off project site topsoil for testing and/or stockpile stripped topsoil from the project for testing. Perform the Soil Analysis Test from these stockpiles to determine the percent of organic matter present. The topsoil shall contain between 4 percent and 20 percent organic matter as determined by loss on ignition of samples oven dried to constant weight at 212 °F (100 °C) and consist of fertile, loose, friable, and loamy material that contains humus material. For topsoil to be considered loamy, ensure that the fraction passing the No. 10 (200) sieve does not contain more than 40 percent clay. Test topsoil according to AASHTO T 267.

The Department will review the sample test results and approve the stockpiles for use. Stockpiles outside the above limits will not be used.

Stripped topsoil from the R/W limits will be from the upper most layers of the excavation areas. Remove all heavy grass, weeds, and other vegetation before stripping topsoil from the excavation areas.

A mixture of 1 part compost and 2 parts topsoil will be treated as topsoil.

659.06 Compost. Acceptable compost shall include Ohio EPA rated Class IV compost, EQS biosolids compost, or a Department approved equal. Furnish compost with a nitrogen content of 1.4 percent or above. Obtain compost from an Ohio EPA approved facility. Before delivering compost, provide the Engineer with the facility name and location.

659.07 Seeds. Furnish grass seed from a grass seed dealer or grower whose brands are grades registered or licensed by the State of Ohio, Department of Agriculture or from the approved list of grass seed dealers or growers on file with Department. Furnish the kind and type of grass seed required that meets current specifications on file with the Department as to percentage purity, percentage weed seed, and percentage germination.

Turf grass germination rates specifications are shown below in Table 659.07-1 to provide an understanding of the specifications on file with the Department along with information to understand what is required.

TABLE 659.07-1 GERMINATION RATES

Species	Minimum Percent	High Quality Percent
Kentucky Bluegrass	80	85
Fine Fescue	85	90
Perennial Ryegrass	85	90
Annual Ryegrass	85	90
Tall Fescue	85	90
Creeping Red Fescue	85	90

If high quality is not shown on the plans, then the minimum germination rate is required.

Mark the test date on seed bags. Furnish seeds as separate species and cultivars, packaged together or bagged separately, and labeled, tagged, or marked according to ORC 907.03. Sow seeds within 15 months of the testing date. The Department reserves the right to test, reject, or approve all seed after delivery.

659.08 Legumes. Inoculate or treat all leguminous seeds (crown vetch) with the proper amount of pure nitrogen-fixing bacteria and mix with sufficient water to thoroughly wet the seed. The bacteria selected will be for maximum vitality and shall not be more than one-year old. All culture records will be provided with the leguminous seeds.

If sown hydraulically, use 4 times the inoculant rate specified by the inoculant manufacturer. If pre-inoculated seed is used then use 3 times the inoculant rate specified by the inoculant manufacturer. Immediately before seeding, add inoculant and sticking agent directly into the slurry, and thoroughly mix the slurry. Sow seed as soon as possible after inoculation. If left standing for more than 24 hours, reinoculate seed before sowing. Mix all seed on the project. Sixty days before seeding, provide a written description for the Class 3C mixture showing the percentage by weight (mass) of each kind of seed for the Engineer's approval.

Include the following with the description:

A. Name and location of the seed supplier.

B. Origin and date of harvest of each kind of seed.

C. A statement of the purity and germination of each seed.

D. Testing date for each seed.

E. How and when seeds were mixed.

659.09 Native Grasses and Wildflowers. Table 659.09-1 lists the seed quantities by weight per area. Use Classes 4, 5, and 6 in the amounts of pure live seed (PLS) for each species listed. If seed tests show that the seed has an actual pure live seed (PLS) yield less than the intended yield, adjust the specified quantity to provide the intended PLS yields.

For Class 4, 5, and 6 mixtures, provide seed specifically grown for the Ohio climate.

Use cool season turf Classes 1, 2, 3A, and 3B as listed in Table 659.09-1 composed of no less than two and no more than four cultivars of the same species. Sixty days before seeding, provide a written description for the Class 1, 2, and 3A mixtures showing the percentage by weight (mass) of each kind of seed for the Engineer's approval. Mix all seed on the project. Sixty days before seeding, provide a written description for the Classes 1, 2, 3A, 3B, 4, 5, and 6 mixtures showing the percentage by weight (mass) of each kind of seed for the Engineer's approval.

Include the following with the description:

A. Name and location of the seed supplier.

B. Origin and date of harvest of each kind of seed.

C. A statement of the purity and germination of each seed.

D. Testing date for each seed.

E. How and when seeds were mixed.

TABLE 659.09-1 GRASS AND WILDFLOWER SEED MIXES

Class	Mix Type Seeds	Weight per Area lb 1000 ft^2	 kg 1000 m^2
1	Lawn Mixture Use for areas in front of residences, commercial properties, etc. between curb and sidewalk with slopes 3:1 or flatter.		
	Kentucky Bluegrass (Poa pratensis)	3	14.64
	Creeping Red Fescue (Festuca rubra)	3	14.64
	Annual Ryegrass (Lolium multiflorum)	2	9.76
	Perennial Ryegrass, turf type (Lolium perenne)	2	9.76
2	Roadside Mixture		
	Kentucky Bluegrass (Poa pratensis)	1.5	7.32
	Kentucky 31 Fescue (Festuca arundinacea var. KY 31 or Fawn Tall Fescue)	2	9.76
	Perennial Ryegrass (Lolium perenne)	1.5	7.32
3A	Slope Mixtures Use for slopes flatter than or equal to 3:1.		
	Use Class 2, 3B, 3C, or 4B mixtures		
3B	Low Growing Slope Mixture Use for slopes steeper than 3:1 when low growing species are required		
	Hard Fescue (Festuca longifolia)	1.3	6.35
	Creeping Red Fescue (Festuca rubra)	0.8	3.9
	Annual Ryegrass (Lolium multiflorum)	0.23	1.12
3C	Crown Vetch Mixture Use for slopes steeper than 3:1 and shale or rock slopes.		
	Crown Vetch (Coronilla varia)	0.9	4.39
	Perennial Ryegrass (Lolium perenne)	1.8	8.79
	Annual Ryegrass (Lolium multiflorum)	0.3	1.46
4A	Native Grass Mixture Use for slopes flatter than 2:1 and seeding for wildlife habitat mitigation.		
	Big Bluestem (Andropogon gerardii)	0.07	0.34
	Indiangrass (Sorghastrum nutans)	0.09	0.44
	Switchgrass (Panicum virgatum)	0.02	0.09
	Annual Ryegrass (Lolium multiflorum) spring fall	0.11 0.34	0.54 1.66
4B	Low Growing Native Grass Mixture Use for slopes flatter than 2:1 and seeding for wildlife habitat mitigation when low growing species are required.		
	Little Bluestem (Schizachyrium scoparium)	0.18	0.88

Class	Mix Type Seeds	Weight per Area lb 1000 ft^2	 kg 1000 m^2
	Sideoats Grama (Bouteloua curtipendula)	0.04	0.19
	Prairie Dropseed (Sporobolus heterolepis)	0.04	0.19
	Annual Ryegrass (Lolium multiflorum) spring fall	0.11 0.34	0.54 1.66
5A	Annual and Perennial Wildflower Mixture Use for slopes flatter than 2:1 and seeding for wildlife habitat mitigation.		
	Annual Mixture Do not exceed 25% by weight of any one of the following species:	0.07	0.34
	Corn Poppy (Papaver rhoeas)		
	Cosmos (Cosmos bipinnatus)		
	Yellow Cosmos (Cosmos sulphureus)		
	Cornflower (Centaurea cyanus)		
	Rocket Larkspur (Delphinium ajacis)		
	Indian Blanket (Gaillardia pulchella)		
	Perennial Wildflower Mixture Do not exceed 50% by weight PLS of any one of the following species:	0.28	1.37
	Black-eyed Susan (Rudbekia hirta)		
	Purple Coneflower (Echinacea purpurea)		
	Lance-leaved Coreopsis (Coreopsis lanceolata)		
5B	Native Wildflower and Grass Mixture Use for slopes flatter than 2:1 and seeding for wildlife habitat mitigation.		
	Native Wildflower Mixture Do not exceed 10% by weight PLS of any one of the following species:	0.34	1.66
	Butterfly-weed (Asclepias tuberosa)		
	New England Aster (Aster novae-angliae)		
	Partridge Pea (Cassia fasciculata)		
	Purple Coneflower (Echinacea purpurea)		
	Rattlesnake Master (Eryngium yuccifolium)		
	Ox-eye Sunflower (Heliopsis helianthoides)		
	Wild Bergamot (Monarda fistulosa)		
	Greyhead Coneflower (Ratibida pinnata)		
	Orange Coneflower (Rudbekia fulgida)		
	Prairie Dock (Silphium terebinthinaceum)		
	Whorled Rosinweed (Silphium trifoliatum)		
	Stiff Goldenrod (Solidago rigida)		
	Grass Mixture		
	Big Bluestem (Andropogon gerardii)	0.046	0.22
	Little Bluestem (Schizachyrium scoparium)	0.069	0.34
	Indiangrass (Sorghastrum nutans)	0.023	0.11
	Annual Ryegrass (Lolium multiflorum)	0.92	4.49

Class	Mix Type Seeds	Weight per Area lb 1000 ft^2	 kg 1000 m^2
6	Wildlife Mixture Use for slopes flatter than 2:1 and seeding for wildlife habitat mitigation.		
	Big Bluestem (Andropogon gerardii)	0.13	0.63
	Little Bluestem (Schizachyrium scoparium)	0.18	0.88
	Indiangrass (Sorghastrum nutans)	0.13	0.63
	Ox-eye Sunflower (Heliopsis helianthoides)	0.18	0.88
	Prairie Dock (Silphium terebinthinaceum)	0.18	0.88
	Purple Coneflower (Echinacea purpurea)	0.18	0.88
	Whorled Rosinweed (Silphium trifoliatum)	0.11	0.54
	Downy Sunflower (Helianthus mollis)	0.07	0.34
	New England Aster (Aster novae-angliae)	0.07	0.34
	Annual Ryegrass (Lolium multiflorum) spring fall	0.11 0.34	0.54 1.66
7	Temporary Erosion Control Mixture		
	Annual Ryegrass (Lolium multiflorum)	2.02	9.86

659.10 Site Preparation. Before placing topsoil or seed remove rock or other foreign material of 3 inches (75 mm) or greater in any dimension, from all areas except as listed below.

A. Remove stones 1-inch (25 mm) or greater in any dimension from all seed areas from in front of residences, commercial properties, etc.; between curb and sidewalks; or as shown on the plans.

B. Remove nothing in shale cuts, but allow the shale to deteriorate to a soil type surface before seeding or placing topsoil.

Finish the area in such a manner that seeding, place sod, planting, or, placing topsoil can proceed without additional soil preparation.

Apply commercial fertilizer, lime, or other soil amendments including compost to the soil or topsoil surface in separate operations. Incorporate the commercial fertilizer, granular lime, or other soil amendments, including compost either separately or together, into the soil or topsoil to a depth of 2 to 4 inches (50 to 100 mm). Do not mix Liquid lime into the soil or topsoil. Only apply liquid lime to the top of the soil or topsoil. Furnish a smooth surface for the seed or topsoil by tracking with a dozer or by other methods. If the site is inaccessible to a dozer and other methods do not provide results equivalent to hand raking, hand rake these areas. Ensure that the surface is uniform, free of gullies, rivulets, crusting, and caking. Finely grade the surface for seed or topsoil for slopes 4:1 or flatter, and grade all other slopes. Rake or open the surface with a dozer cleats or otherwise loosen the surface of these areas to a depth of 1 inch (25 mm) immediately before covering with topsoil. Remove raked up material from the area.

659.11 Placing Topsoil. If shown on the plans, place topsoil in loose lifts that construct a 4-inch (100 mm) compacted depth. The surface of the topsoil shall be such that the final grade as shown on the cross-sections is met. Use the following

methods or combination of any of the methods to produce the required space to place the topsoil.

A. The 203 Items can be cut or placed to the final grade, which will match the plan quantities for Items 203, and then remove a 4-inch (100 mm) thickness for the topsoil.

B. The 203 Items can be cut or placed to a 4-inch (100 mm) height below the final grade. There will be no change from the plan quantities in the 203 Items for this method.

Track the area with a dozer to compact and provide good contact between the topsoil and the surface.

The Contractor may place topsoil by using pneumatic, or hydraulic methods. If using pneumatic or hydraulic methods to place the topsoil, the Contractor may place the top 1-inch (25 mm) with a mix of seed, commercial fertilizer, lime, and other soils amendments. This mixture will be 1 part compost and 2 parts topsoil. Do not apply mulch to this surface. The compost is the mulch.

659.12 Seeding Methods. Apply seed to prepared areas. If the prepared areas to be seeded become compacted before seeding, loosen the surface using disks, rakes, or other methods.

Thoroughly mix all seed, and evenly sow the seed over the prepared areas at the required rates. Do not sow seed during high winds. For slopes subject to windy conditions, seed using hydraulic methods only. Operate equipment in a manner to ensure complete coverage of the entire area to be seeded.

If broadcast seeding, seed Classes 1, 2, 3A, and 3B between August 15 to October 30. If necessary to seed Classes 1, 2, 3A, or 3B before August 15, but after March 1 increase the seeding rates by 5 percent.

Between March 1 and October 30, the Contractor may use hydro seeding, which applies the mulch, seed, water, and commercial fertilizer in the same operation, for Classes 1, 2, 3A, 3B, 3C, and 7.

Between October 30 and March 1, apply temporary seed according to Item SS832. With the Engineer's approval, the Contractor may apply permanent seed between October 30 and March 1 on projects started and completed within the same calendar year.

Seed before or concurrently with all required erosion control items.

Do not apply crown vetch seed from September 1 to October 31.

Wildflower Classes 5 and 6 seed from September 1to October 30, unless the Engineer allows seeding from March 1 to May 31.

Seed Class 4 wildflowers from March 1 to May 31.

Seed native grasses and wildflowers in Classes 4, 5, and 6 with a rangeland type, slit seeder or native seed grass drill. Seed native grasses with no less than two passes in different directions and by equally splitting the seed application rate to each pass. Use broadcast seeding, along with cultipacking or rolling, only with the Engineer's approval.

If broadcast seeding, perform the following, immediately after sowing, to provide good seed-soil contact:

A. For flat surfaces, lightly rake the area then roll.

B. For slopes, track the area with a dozer.

659.13 Mulching Operation. Mulch materials consist of straw, compost, or wood fiber for 3:1 or flatter slopes. The Contractor may specify which mulch to use, if it is not shown on the plans. Use mulch that is reasonably free of weed seed, foreign materials, or other materials that would prohibit seed germination. Do not mulch during high winds. For slopes subject to windy conditions mulch using hydraulic methods only. Within 24 hours after seeding an area, evenly place mulch. Immediately replace mulch that becomes displaced.

659.14 Straw Mulch. Straw mulch consists of straw. Evenly place straw mulch over all seeded areas at the following rates:

Seeding Period	Rate
From March 15 to October 30	2 tons per acre (0.5 metric ton/1000 m^2)
From October 31 to March 14	3 tons per acre (0.7 metric ton/1000 m^2)

Keep straw mulching materials in place by applying an asphalt emulsion at a minimum rate of 60 gallons per ton (250 L/metric ton) of straw mulch or by applying tackifiers according to the manufacturer's recommendations. Apply an additional application at a rate of 30 gallons per ton (125 L/metric ton) of straw mulch to shoulder areas, starting at the berm edge and extending out for a distance of 10 feet (3 m). Use an emulsion that is nontoxic to plants and prepared in a manner that will not change during transportation or storage.

659.15 Wood Fiber Mulch. Wood fiber mulch consists of pure wood fibers manufactured expressly from clean wood chips. Ensure that the chips do not contain lead paint, varnish, printing ink, and petroleum based compounds. Do not use wood fiber mulch manufactured from recycled materials of unknown origin such as sawdust, paper, cardboard, or residue from chlorine-bleached pulp and paper mills.

Ensure that the wood fiber mulch maintains uniform suspension in water under agitation and blends with grass seed, commercial fertilizer, and other additives to form a homogeneous slurry. Use manufacturer-approved tackifiers.

Using standard hydraulic mulching equipment, evenly apply the slurry over the soil surface in a one-step operation. Apply slurry from March 1 to October 30 at the following rates:

Surface	Rate
Slopes 3:1 or flatter	46 pounds per 1000 square feet (225 kg/1000 m^2)

659.16 Compost Mulch. The Contractor may provide compost applied to a minimum depth of 1/4-inch (6 mm) over the prepared seed areas. The Contractor may also mix the grass seed with the compost and using pneumatic equipment, place this mixture to a minimum depth of 1/4-inch (6 mm) over the prepared seed areas. If using compost no tackifiers or asphalt emulsion are required.

659.17 Watering. Thoroughly water all permanent seeded areas (Classes 1 to 6) after the seed has germinated. Apply a total rate of 300 gallons per 1000 square feet (12.2 m^3/1000 m^2) in at least 2 applications spread over 7 days. Apply the water using a hydro-seeder or a water tank under pressure with a nozzle that produces a spray that will not dislodge the mulch material.

Perform a secondary water application between 7 and 10 days after the primary applications. If 1/2-inch (13 mm) or greater of rainfall has occurred within the first 7-day period, the Contractor may delay or omit the secondary application, depending on weather conditions.

659.18 Maintenance. Maintain all seeded and mulched areas until final inspection. Repair damaged areas to the original condition and grade.

659.19 Mowing. The Engineer may require mowing before permanent seeding and during the growing season following permanent seeding. The Engineer will notify the Contractor of when to begin each mowing. Use suitable mowing equipment of the rotary, flail, disk, or sickle type. Use handheld equipment where inacessible by larger equipment. Do not bunch or windrow mowed vegetation. Mow to a final cutting height of no less than 6 inches (150 mm). If necessary to achieve the cutting height, make more than one pass with the mower.

659.20 Repair Seeding and Mulching. Repair all damage or erosion of the seeded and mulched areas before the completion of the project.

Rework or reshape slopes, and bring in additional material, as necessary, using whatever equipment is necessary to restore slopes to grade. Seed and mulch repaired areas according to this specification. As an alternative, the Contractor may apply compost to repair areas as specified in Item 659.

659.21 Inter-Seeding. Inter-seeding is seeding existing thin and spotty growing turf using a slit or drill type seeder. Perform inter-seeding only from March 15 to May 15 and from September 1 to October 15. If necessary to achieve good seed-soil contact, mow before seeding according to Item 659.

For seeding steep slopes or inaccessible areas, the Contractor may use broadcast or hydraulic seeding methods. Broadcast commercial fertilizer over affected areas as specified in Item 659. Water affected areas at the rate specified in 659 to aid in seed-soil contact.

659.22 Fertilization: 2nd Application. Once all repair seeding and mulching, and inter-seeding is complete and no earlier than 3 months after seeding, perform a Soil Analysis Test if shown on the plans to determine the need for a second application of commercial fertilizer. Do not apply the second application of commercial fertilizer unless the grass has germinated. Broadcast commercial fertilizer of 12-12-12 evenly over the surface without incorporation at a rate of 10 pounds per 1000 square feet (0.05 kg/m^2).

659.23 Performance. The Department will inspect all seeded areas no earlier than 6 months and no later than 12 months after final seeding. For any area identified without a uniform density of at least 70 percent grass cover, repair seeding and mulching as specified in 659 or perform inter-seeding as specified in 659, and fertilize as specified in this subsection.

Also repair seeding and mulching or perform inter-seeding, and fertilize seeded areas damaged by traffic or erosion, due to no fault or negligence of the Contractor.

659.24 Method of Measurement. The Department will measure Soil Analysis Test by the number of tests submitted to the Engineer.

The Department will measure the compacted topsoil by the number of cubic yards (cubic meters).

The Department will measure Commercial Fertilizer by the number of tons (kilograms) of each quantity of furnished, spread, and incorporated into the soil or topsoil. This measure will be converted to the standard application rate for the standard mixture ratio.

The Department will measure lime or liquid lime by the number of acres (ha) furnished, spread, and incorporated into the soil or topsoil. The measure will be converted to the standard application rate for the standard mixture ratio.

The Department will measure Seeding and Mulching by the number of square yards (square meters).

The Department will measure Repair Seeding and Mulching by the number of square yards (square meters) of damaged or eroded areas reshaped, seeded, and mulched. If compost is substituted for mulch to repair areas, the Department will include such work under Repair Seeding and Mulching.

The Department will measure Water by the number of M gallons or 1000 gallon units (cubic meters) applied. The Department will measure water in tanks, tank wagons, or trucks of predetermined capacity, or by means of meters of a type satisfactory to the Engineer and furnished and installed by the Contractor at expense to the Department, or determined by weight conversion.

The Department will measure Inter-Seeding by the number of square yards (square meters) of the seeded area.

The Department will measure mowing by the number of M square feet (square meters) satisfactorily mowed.

If seeded areas are damaged by traffic or erosion, due to no fault or negligence of the Contractor, the Department will measure for such work and mobilization by Supplemental Agreement.

The Department will not measure for repairs to seeding and mulching if damage or erosion of the areas occurs as a result of fault or negligence of the Contractor.

659.25 Basis of Payment.

The Department will pay the plan quantity for compacted topsoil. The Department will not adjust topsoil quantities when the volume between two consecutive cross-sections differs by less than 5 percent from the plan quantity, unless the difference between the actual quantity and plan quantity is greater than 1000 cubic yards (1000 m^3). For quantity differences greater than 5 percent or greater than 1000 cubic yards (1000 m^3), submit supporting documentation to the Engineer.

The Department will pay the plan quantity for Seeding and Mulching. The Department will not adjust Seeding and Mulching quantities when the area between two consecutive cross-sections differs by less than 5 percent from the plan quantity, unless the difference between the actual quantity and plan quantity is greater than 20,000 square yards (20,000 m²) for all Seeding and Mulching pay items, combined. For quantity differences greater than 5 percent or greater than 20,000 square yards (20,000 m²), submit supporting documentation to the Engineer.

The Department will pay for accepted quantities at the contract prices as follows (M=1000):

Item	Unit	Description
659	Each	Soil Analysis Test
659	Cubic Yard (Cubic Meter)	Topsoil
659	Ton (Kilogram)	Commercial Fertilizer
659	Acres (ha)	Lime
659	Square Yard (Square Meter)	Seeding and Mulching
659	Square Yard (Square Meter)	Seeding and Mulching for Wildlife
659	Square Yard (Square Meter)	Seeding and Mulching Class ___
659	Square Yard (Square Meter)	Repair Seeding and Mulching
659	M Gallons (Cubic Meters)	Water
659	Square Yard (Square Meter)	Inter-Seeding
659	M Square Feet (Square Meter)	Mowing

ITEM 660 SODDING

660.01 Description. This work consists of furnishing, hauling, excavating for and preparing the bed, and placing sod.

660.02 Materials. Furnish sod consisting of well-rooted Kentucky Blue Grass (Poa pratensis) or Canadian Blue Grass (Poa compressa) containing a growth of not more than 30 percent of other grasses and clovers, and free from all noxious weeds such as wild mustard, thistles, quack grass, and Johnson grass, and reasonably free from dandelions and crab grass.

Ensure that all sod is certified by the sod supplier that it complies with this item. Ensure that the sod was recently mowed to a height of not more than 3 inches (75 mm). Furnish a certificate with each shipment, and furnish the following additional information from the sod supplier:

A. The name of the producer.

B. The amount of sod shipped in square yards (square meters).

C. The location of sod field.

D. The location of job site.

E. The date sod was cut.

F. The thickness the sod was cut.

Furnish wood stakes that are at least 1/2 × 3/4 × 12 inches (13 × 19 × 300 mm).

Furnish T-pins that are 18-inch (450 mm) in length and ¼ inch (6 mm) in diameter and have a 3-inch (75 mm) tee.

Furnish round pins that are 18-inch (450 mm) in length and ¼ inch (6 mm) in diameter and have a 1.5-inch (38 mm) washer.

Furnish galvanized poultry netting 50 inches (1200 mm) wide with 2-inch (50 mm) mesh and No. 20 gage minimum wire.

Furnish fertilizer and lime according to Item 659.

Furnish sod materials according to the Department's Qualified Product List (QPL).

660.03 Lifting Sod. Furnish sod strips that are not less than 3 feet (0.9 m) and not over 6 feet (1.8 m) in length with a uniform width of not over 24 inches (0.6 m). Furnish sod strips that lay flat on skids. The Contractor may elect to deliver sod rolls of up to 25 feet (7.6 m) in length. Furnish sod rolls that are pre-rolled on skids. Furnish sod cut to a depth equal to the growth of the fibrous roots but in no case less than 1 inch (25 mm).

Deliver sod to the job within 24 hours after being cut, and install it within 48 hours after being cut.

During wet weather, allow the sod to dry sufficiently to prevent tearing during handling and placing. During dry weather, water the sod before lifting to ensure its vitality and to prevent the dropping off of the soil in handling.

660.04 Preparation of Areas to be Sodded. Before placing the sod, excavate the sod bed to a depth that when the sod is in place the top of the sod is flush with the surrounding grade and conforms to the typical cross-section. If specified, place the topsoil according to Item 659. If specified under Item 659, apply commercial

fertilizer and agricultural liming material. Incorporate these materials in the areas to be sodded at the rate specified in 659.03 and 659.04 to a depth of not less than 1 inch (25 mm). Incorporate these materials within 48 hours prior to placing the sod. Immediately before placing the sod, rake the area or otherwise bring it to an even surface forming a proper sod bed. If the area is dry, thoroughly water the sod bed.

660.05 Placing Sod On Slopes 3 to 1 or Flatter. Do not place any sod when the temperature is below 32 °F (0 °C). Do not place any frozen sod, and do not place any sod upon frozen soil. When placing sod between June 1 and October 15, cover it immediately with straw mulch 1 inch (25 mm) thick, loose measurement.

Lift sod from trucks or storage piles, and place it by hand with close joints and no overlapping. Plug all gaps between sections of sod and openings at angles with sod. After laying, thoroughly water the sod, and tamp the sod with approved sod tampers sufficiently to bring the sod into close contact with the sod-bed and to ensure tight joints between the sections or strips. Upon placing the sod, ensure that the surface of the sodded areas coincides with the finished grade.

660.06 Placing Sod on Slopes Steeper Than 3 to 1 But Flatter Than 2 to 1. Place sod on slopes steeper than 3 to 1 but flatter than 2 to 1 according to 660.05, with the following modifications.

Lay sod with the long edges of the strip parallel to the contour starting at the bottom of the slope. Neatly match successive strips, and stagger all joints by at least 12 inches (300mm).

For sod placed 6 feet (1.8 m) or greater in height (measured along the slope), stake each strip or roll securely along all sides with stakes not more than 2 feet (0.6 m) apart with the flat side against the slope or with pins not more than 2 feet (0.6 m) apart. Drive the wooden stakes so that the last 1 inch (25 mm) remains above the top of the sod. Drive pins 1 inch (25 mm) below the top of the grass.

After laying, thoroughly water the sod, and tamp the sod with approved tampers sufficiently to bring the sod into close contact with the sod-bed and to ensure tight joints between the sections or strips.

660.07 Placing Sod in Ditches. Place sod in ditches according to 660.05, with the following modifications.

Place sod in ditches with joints staggered at least 12 inches (300 mm). Stake each strip or roll securely along all sides with wooden stakes not more than 2 feet (0.6 m) apart with the flat side against the slope. Drive the wooden stakes so that the last 1 inch (25 mm) remains above the top of the sod.

660.08 Placing Reinforced Sod On Slopes 2 to 1 or Steeper. Place reinforced sod on slopes 2 to 1 or steeper or as specified in the plans according to 660.05, with the following modifications. Before placing the sod, place the galvanized poultry netting or equivalent. Stake the galvanized poultry netting or equivalent securely to the subgrade by using pins or wood stakes. Place the pins or wooden stakes at 4 foot (1.2m) intervals. Fasten the netting to the wooden stakes with staples. Where the sod width is from 8 to 10 feet (2.4 to 3 m) wide, the Engineer will allow two strands of netting for a total width of 8 feet (2.4 m). For sod, stake each strip or roll securely along all sides with wooden stakes not more than 2 feet (0.6 m) apart with the flat

side against the slope or with pins not more than 2 feet (0.6 m) apart. Drive the wooden stakes so that the last 1 inch (25 mm) remains above the top of the sod. Drive pins 1 inch (25mm) below the top of the grass.

660.09 Watering. Keep all sodded areas thoroughly moist for 30 days after sodding. Repair any areas damaged following installation. Ensure that sod is in place for at least 30 days before final acceptance.

660.10 Method of Measurement. The Department will measure Sodding Unstaked, Sodding Staked, and Sodding Reinforced by the actual number of square yards (square meters) of area sodded, completed and accepted.

660.11 Basis of Payment. If required, the Department will pay for topsoil liming and fertilizing under Item 659.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
660	Square Yard (Square Meter)	Sodding Unstaked
660	Square Yard (Square Meter)	Sodding Staked
660	Square Yard (Square Meter)	Sodding Reinforced

ITEM 661 PLANTING TREES, SHRUBS, PERENNIALS AND VINES

661.01 Description. This work consists of furnishing, planting and maintaining trees, shrubs, perennials, and vines, described in the plans. Additionally, provide landscape watering according to Item 662.

661.02 Plant Materials. Plant materials include all trees, shrubs, perennial and vines, and plants required as part of the Work. Provide plant materials that are sourced from nurseries licensed by the Ohio Department of Agriculture or state equivalent, healthy specimens, typical of their species or variety, and that exhibit a normal habit of growth as set forth in the most current edition of the American Standard for Nursery Stock (ANSI Z60).

661.03 Location and Source of Supply. Supply the Engineer with complete and detailed information concerning the source of supply for each item of required plant material within 15 days after receiving the notice of award of the Contract.

Ensure that all plant materials have been grown in the same hardiness zone or 1 zone colder than the project.

661.04 Transportation, Storage, and Handling. Transport all plants from nursery sources to the project site with the entire load completely covered for protection from drying winds. Thoroughly water all plants that cannot be immediately planted so as to keep the roots in a continually moist and protected condition. The Engineer may reject plants that are not adequately protected during transportation and storage. Immediately remove all rejected plant materials from the project site. Handle all plant materials by the root ball or container.

661.05 Labeling. Attach legible labels to all specimens, or boxes, bundles, and other containers, indicating detailed information including, but not limited to, the botanical genus and the species name, the common name, the size or age of each species or variety and the quantity contained in the individual bundles or boxes. Remove all labels no more than two weeks prior to the completion of the establishment period. Notify the Engineer prior to removing the plant material labels.

661.06 Acceptance. Prior to acceptance by the Engineer, notify the Engineer when plant materials are delivered to the project site. Ensure that the plant species delivered are as described in the plans and are healthy, vigorous, and free from harmful plant diseases, and insect pests. Stockpiled materials can be inspected by ODA with advanced notice. Species substitutions must have written approval from the project engineer prior to delivery to the project.

Do not install any plant materials until the Engineer provides the Contractor with notification that the plant materials have been accepted.

661.07 Scheduling. Install all plant materials after March 15 and before June 1 or after September 15 and before November 30. Do not install plant materials in frozen or saturated soil conditions. Ensure a sufficient water supply is available to satisfy the requirements of the plant materials and Item 662.

661.08 Layout of Plant Materials. Before installation, use suitable staking to lay out the locations of all planting holes and beds. Provide the Engineer with a scaled drawing that indicates the location, species, and size of plant materials required in the plan. Obtain the Engineer's approval of these locations before installation.

661.09 Backfill Mix. For all plantings, use backfill mix consisting of the following:

A. One part soil.

B. One part sphagnum peat moss, shredded pine bark, or EPA rated Class IV compost.

C. One part sand.

Do not use backfill mix that is frozen or muddy.

661.10 Planting.

A. Planting Holes: Dig planting holes that have sloping side walls and are 'bowl shaped'. Slope the side walls to approximately 45 degrees. Dig the planting hole so that the diameter at the top is at least two times the diameter of the root ball. Dig the planting hole to the same depth as the root ball structure.

Dig planting holes for vines and perennials to a minimum depth and diameter of 6 inches (150 mm). Make planting holes for rooted cuttings and tree seedlings large enough to accommodate the root system.

B. Planting Beds: One month before cultivation, treat all planting beds that are to be developed in areas of existing turf with pre-emergent and post-emergent type herbicides. Use a State-licensed pesticide applicator to apply the herbicide according to the manufacturer's instructions.

Before planting, top dress all planting beds with a minimum of 2 inches (50 mm) of backfill mix, then cultivate it to a depth of 6 inches (150 mm) using a plow, disc, or roto-tiller.

C. Planting Trees & Shrubs: Set each plant in the center of the planting hole, plumb, and straight at a level such that the top of the root structure (i.e., trunk flare or root collar) is 1 inch (25 mm) above the surrounding soil. Set the root ball on compacted or unexcavated soil to prevent settlement. Prior to backfilling the hole, remove all twine, bags, and roping. For trees shipped with wire baskets supporting the root structure, remove the top two-third of the wire basket from root balls. Remove all rot-proof burlap. Remove or fold down the top one-third of standard (biodegradable) burlap. Take care not to separate the soil of the root ball from the plant's root system. Cut or remove circling roots before planting.

Backfill the planting hole with the backfill mix. Fill the hole gradually and settle the backfill with water to the top of the root structure. Do not place backfill mix in direct contact with the trunks or stems. Add backfill mix around the root structure up to the plant's root collar is at the soil surface.

Do not plant groundcovers, vines, or perennials closer than 12 inches (300 mm) to tree trunks and shrub stems or within 6 inches (150 mm) of the edge of planting beds.

D. Planting Seedlings, Groundcovers, Vines or Perennials: For seedlings, groundcovers, vines, or perennials that are not in a planting bed, , remove all grass and weeds by scalping an area that has a minimum diameter of 12 inches (300 mm). Plant seedlings or perennials in the center of the scalped area using a spade or planting bar.

661.11 Landscape Mulch. Provide Landscape Mulch that consists of shredded bark and shredded wood. The length of any individual component cannot exceed 2 inches (50 mm). Ensure that at least 75 percent of the mulch can pass a 1 inch (25 mm) screen. Landscape Mulch may contain up to 50 percent shredded wood. Wood chips are not acceptable. Provide mulch that is free of soil, rocks, and weeds, and that has been aged at least one year before installation.

Smooth and shape the backfill mix to form a shallow basin slightly larger than the planting hole. Mulch these areas with a 4 inch (100 mm) layer of Landscape Mulch uniform in texture and size. Do not place mulch in direct contact with the trunks of any trees. Rake and smooth all planting beds upon completion of the work.

661.12 Wrapping. Wrap all single deciduous tree trunks of 1 inch (25 mm) caliper and larger. Before wrapping, inspect for insect infestation and take corrective measures. Wrap trees within 48 hours after planting, using a double-layered, bituminous-cemented, waterproof, crinkled paper. Start at the ground and wrap the trunk neatly and snugly to the height of the first branches, then attach securely. With each turn of the wrapping, overlap the previous turn by half the width of the paper.

661.13 Bracing. Use only flexible, biodegradable ties when bracing trees. Use bracing only in areas where mower damage, vandalism, or windy conditions are a concern or as directed by the Engineer. Install loose fitting ties that will not girdle the trunk. Ensure that the tie will allow trunk movement and growth. Install all bracing as shown on the standard construction drawing.

661.14 Period of Establishment. Before final inspection, install all plants and care for them for a period of establishment. The period of establishment begins immediately upon completion of the planting operations and continues until October 1. The minimum period of establishment is one complete growing season, beginning June 1 and ending the following October 1.

During the period of establishment, follow standard horticultural practices to ensure the vigor and growth of the transplanted material including watering (according to Item 662), re-mulching, re-staking, and cultivating as necessary. Prune branches of deciduous plants to preserve the natural characteristics of the species according to ANSI Pruning Standards (ANSI A300). Remove broken, damaged, and dead branches. Do not trim the central leader of trees.

Completely remove weeds and grasses from the planted and mulched areas by weeding and mowing (around trees, shrubs, and bed edges) at least two times during the growing season. Weed and mow the first time on or about June 15 and again approximately 8 weeks later.

661.15 Final Acceptance. On or about October 1 at the end of the establishment period, the Engineer, in coordination with the Department's Office of Environmental Services, will inspect the plantings and supply the Contractor with a list of plant materials that do not comply with the contract requirements. Install all replacement plantings in accordance with the contract requirements. Replacement plants are subject to a new establishment period. Care for, water and maintain the replacement plant materials throughout the new establishment period at no additional cost to the State.

661.16 Removal of Stakes and Wrapping. After receiving notification from the Department of the date of the final inspection, remove all stakes and wrapping material from all plants not more than 14 days before the final inspection, with the exception of the replacement plantings that have not been in place for a full growing season.

661.17 Method of Measurement. The Department will measure the number of healthy plant materials that exhibit typical growth habit for the species and variety.

The Department will measure each species and size, completed and accepted in place.

The cost associated with wrapping, bracing, mulching and staking is included in the unit price bid for Item 661 Planting Trees, Shrubs, Perennials and Vines.

If the Contract does not include an estimated quantity for Item 662 Landscape Watering, the Department will not pay for landscape watering separately. In this case, include the cost of landscape watering in the unit price bid for Item 661 Planting Trees, Shrubs, Perennials and Vines.

661.18 Basis of Payment. The Department will pay 40 percent of the bid price for plant materials delivered and accepted at the project site. The Department will pay 40 percent of the bid price when the plant materials have been installed. The Department will pay the remaining 20 percent of the bid price at the end of the establishment period following final acceptance.

If for each pay item, less than or equal to 5% of the installed plants require replacement at the time of Project Completion, the Engineer may waive the establishment period for the replacement plantings, provided that the replacement plantings are installed in accordance with this specification and in the presence of the Engineer or Inspector.

If for each pay item, more than 5% of the installed plants require replacement at the time of Project Completion, the Contractor is required to install the replacement plantings in accordance with this specification. The Department will pay the remaining percentage of the bid price at the time of Project Completion. The replacement plantings are subject to the one year establishment period regardless of the Project Completion date. After the replacement plantings complete the one year establishment period, the Department will inspect the replacement plantings and notify the Contractor of the Departments' findings. As final remedy under the contract, the Contractor is required to install replacement plants for all plantings that did not survive the establishment period at no additional cost to the State.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
661	Each	Tree Seedling, (Size), (Species)
661	Each	Perennials, (Size), (Species)
661	Each	Groundcover and Vines, (Size), (Species)
661	Each	Deciduous Shrub, (Size), (Species)
661	Each	Evergreen Shrub, (Size), (Species)
661	Each	Deciduous Tree, (Size), (Species)
661	Each	Evergreen Tree, (Size), (Species)

ITEM 662 LANDSCAPE WATERING

662.01 Description. This work consists of furnishing, delivering, applying, measuring, and scheduling a sufficient amount of water necessary to keep each plant included in Item 661 in a healthy growing condition throughout the period of establishment and the Contract.

662.02 Watering. Furnish the water used in watering landscape plants. Thoroughly water all plant material at the time of planting regardless of soil moisture content. Continue to water throughout the period of establishment.

Saturate the root zone and mulched area of each plant without causing run-off according to Table 662.03-1. During fall planting, continue to water until the ground is frozen and recommence watering after the spring thaw. Furnish a rain gauge approved by the Engineer.

662.03 Method of Measurement. The Department will measure Landscape Watering by the number of gallons (liters) delivered to plants from approved metered tanks or individually measured containers as follows:

TABLE 662.03-1 WATERING TABLE

Plant Description	Gallons (L)
Shrubs:	
12 to 36 inches (300 to 900 mm), height	4 (15)
36 inches to 5 feet (900 mm to 1.5 m), height	7 (25)
Trees:	
5 to 8 feet (1.5 to 2.5 m), height	15 (55)
2 to 3 inches (50 to 75 mm), caliper	25 (95)
3 to 4 inches (75 to 100 mm), caliper	30 (115)
Greater than 4 inches (100 mm), caliper	35 (115)

662.04 Basis of Payment. The Department will pay for the accepted quantities at the contract price as follows:

Item	Unit	Description
662	Gallon (Liter)	Landscape Watering

ITEM 666 PRUNING EXISTING TREES

666.01 Description. This work consists of pruning trees.

666.02 Wound Dressing. Use approved material specifically manufactured for tree wound dressing.

666.03 Pruning. Prune all trees to make them shapely, typical of the species, using standard drawings on the plans as a guide. Use approved pruning tools and methods.

Remove all dead wood and dead branches 1 inch (25 mm) or more in diameter. Remove all branches interfering with or hindering the healthy growth of the tree with a good clean cut made flush with the parent trunk. Remove all diseased branches. For branches that may be partly dead, yet have a good healthy lateral branch between the dead part and the base, cut off the branch with a good clean slanting cut close to and beyond the healthy lateral branch.

Remove low hanging, unsound, or unsightly branches on trees or shrubs designated to remain. Remove all branches or growth interfering with the free traffic movement on the highway. Trim branches of trees extending over the roadbed to provide a clear height of 20 feet (6 m) above the roadbed surface.

Cut off all stubs or improper cuts resulting from former pruning or limbs that have been broken flush with the trunk or limb of the tree in order to ensure proper healing.

666.04 Painting. Paint all cuts or wounds measuring 1 inch (25 mm) or more in diameter and all exposed wood and scars resulting from previous work or damage with approved tree wound dressing.

666.05 Removal of Foreign Materials from Trees. Remove all nails, spikes, bolts, wire, or other foreign materials driven into or fastened to the trunk or branches of the tree, or, if directed by the Engineer, cut them flush with the bark of cambium layer to ensure complete healing over.

666.06 Removal of Rubbish. Legally use, burn, or dispose of all material according to 105.16 and 105.17.

666.07 Method of Measurement. The Department will measure Pruning Existing Trees by the number of each size, completed and accepted.

666.08 Basis of Payment. The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
666	Each	Pruning Existing Trees, 3 to 8-inch (80 to 200 mm) Diameter
666	Each	Pruning Existing Trees, 8 to 16-inch (200 to 400 mm) Diameter
666	Each	Pruning Existing Trees, 16 to 24-inch (400 to 600 mm) Diameter

666	Each	Pruning Existing Trees, 24 to 36-inch (600 to 900 mm) Diameter
666	Each	Pruning Existing Trees, 36 inches (900 mm) and Over

ITEM 670 EROSION PROTECTION

670.01 Description. This work consists of furnishing, placing, and maintaining slope, ditch, and vegetated swale erosion protection as shown on the plans.

670.02 Materials. Furnish materials conforming to:

Sodding 660.02
Erosion Control Mats 712.11

For slope erosion protection, the Contractor may use any of the above materials. For ditch erosion protection, use only Item 660 Sodding or Item 671 Erosion Control Mat Type B, C, E, or G or as specified in the plans. For vegetated swale erosion protection, use only Item 671 Erosion Control Mat Type B or as specified in the plans.

670.03 Construction. Install sodding according to Item 660. Install erosion control mats according to Item 671.

670.04 Maintenance. Maintain sodded areas as specified in Item 660. Maintain erosion control mats as specified in Item 671.

670.05 Method of Measurement. The Department will measure Slope Erosion Protection, Ditch Erosion Protection, and Vegetated Swale Erosion Protection by the number of square yards (square meters) completed and accepted. The Department will determine the area based on the surface area covered by the slope, ditch, or swale erosion protection.

670.06 Basis of Payment. The Department will pay for surface preparation, topsoil, lime, fertilizer, seeding and mulching of areas covered by the mats/sodding under Item 659. The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
670	Square Yard (Square Meter)	Slope Erosion Protection
670	Square Yard (Square Meter)	Ditch Erosion Protection
670	Square Yard (Square Meter)	Slope Erosion Protection Mat Type __

670	Square Yard (Square Meter)	Ditch Erosion Protection Mat Type __

ITEM 671 EROSION CONTROL MATS

671.01 Description
671.02 Materials
671.03 Construction
671.04 Maintenance
671.05 Method of Measurement
671.06 Basis of Payment

671.01 Description. This work consists of furnishing, placing, and maintaining Types A through I erosion control mats. This work also consists of furnishing, placing, and maintaining seeding and mulching when the seeding and mulching is to be held in place with erosion control mats.

671.02 Materials. Furnish materials conforming to:

Seed and Mulch 659
Lime and Fertilizer 659
Erosion Control Mats 712.11

If the mat type is not specifically itemized, furnish any mat type listed in 712.11.

Furnish staples consisting of 12 inch (0.3 m) No. 11 gage steel wire bent into narrow U-shape with the ends of the staples approximately 1 inch (25 mm) apart producing a 6 inch staple or furnish pins conforming 18 inch (450 mm) long, 1/4 inch (4.5 mm) in diameter, with attached 1 1/2 inch (38 mm) washer. Drive staples until the staple is flush with the ground surface. Drive pins until the attached washer is flush with the ground surface.

For clay, shale, and other heavy soils, furnish 3 inch (75 mm) steel staples, No. 9 gage or thicker with points approximately 1 inch (25 mm) apart, as required by the Engineer.

671.03 Construction. Before placing any type of temporary erosion control mats, prepare the surface, apply the fertilizer and lime if specified, and seed as specified in Item 659 or as shown on the plans. Place the temporary erosion control mat in the locations shown on the plans.

A. Types A, B, C, E, F, and I. Construct erosion control mat Types A, B, C, E, F, and I as follows:

1. Within 48 hours after seeding and before placing the mat, evenly place mulch over the specified area at the following rates:

a. For straw mulch, use 30 percent of the rate specified in 659.14.

b. For wood fiber mulch, use 30 percent of the rate specified in 659.15.

c. For compost, use the same rate as specified in 659.16.

d. Asphalt emulsion tack or tackifier is not required.

2. Immediately after mulching, lay the mat strips flat, loose, parallel to the flow of water, and with the mat contacting the ground at all points. For mats placed in ditches, start the construction at the downstream end.

3. Where more than one strip is required to cover the area, overlap the strips at least 4 inches (100 mm). Overlap the ends at least 6 inches (150 mm) with the upgrade strip on top.

4. Place upgrade slots at the upgrade end of each strip of mat by placing a tight fold of the mat at least 6 inches (150 mm) vertically into the soil. Firmly tamp the soil against the end and staple the mat. If directed by the Engineer, bury other edges exposed to more than normal flow in a similar manner.

5. Place end slots between the ends of strips by placing a tight fold of the mat at least 6 inches (150 mm) vertically into the soil. Firmly tamp the soil and staple the mat.

6. Place check slots by placing a tight fold of the mat at least 6 inches (150 mm) vertically into the soil. Firmly tamp the soil and staple the mat. Space check slots so that one check slot or an end slot occurs within each 50 feet (15 m) of slope for slopes 3 to 1 or steeper.

7. Bury the edges of the mat where the mat abuts catch basins and other structures.

8. Secure the mat in place with staples driven vertically into the soil. Do not stretch or draw the mat taut during the stapling operation. Install three rows of staples for each strip of mat, with one row along each edge and one row alternately spaced in the middle. Space staples not more than 3 feet (1 m) apart in each row. Staple all upgrade slots, end slots and check slots across the width, with staples spaced not more than 6 inches (150 mm) apart.

9. After completing the mat installation, seed over top of the mat in areas that the Engineer identifies as disturbed. Use a seed mixture conforming to Item 659 at the rate of 1 pound per 1000 square feet (5 g/m^2) or with a mixture or rate shown on the plans.

B. Type G. Construct erosion control mat Type G according to 671.03.A, with the following exceptions.

1. Do not use mulch under the mat.

2. Overlap edges and ends by 1 1/2 inches (40 mm).

3. Do not bury the upgrade end or top edge of each strip unless required by the Engineer due to special conditions in the field.

4. The Contractor may elect not to provide check slots. However upgrade slots and end slots will be furnished.

5. Place the mat in contact with the soil.

671.04 Maintenance. Maintain the specified areas until all work in the Contract has been completed and the Engineer issues the final acceptance. Restore damaged

areas to the condition and grade existing just before placing the mat. Relime, refertilize, and reseed restored areas according to 659. Replace all damaged mats.

671.05 Method of Measurement. The Department will measure Erosion Control Mat, Type ___ by the number of square yards (square meters) completed and accepted. The Department will determine the area based on the surface area covered by the erosion control mat.

671.06 Basis of Payment. The Department will not pay for maintenance as detailed in 671.04 that is required due to the Contractor's negligence, carelessness, or failure to install erosion controls.

If erosion control items in the Contract are properly placed according to the Contract Documents, the Department will pay for maintenance detailed in 671.04 or according to 109.05.

The Department will pay for liming and fertilizing of areas covered by the mats under 659. The Department will not pay for the seeding and mulching performed under or over the mats.

The Department will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
671	Square Yard (Square Meter)	Erosion Control Mat, Type ___
671	Square Yard (Square Meter)	Erosion Control Mat

700 MATERIAL DETAILS

700 MINIMUM REQUIREMENTS FOR SAMPLING MATERIALS

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
203	Embankment	Assure 203.02 Q and R materials conform to the individual material requirements. Sample materials when requested by the Engineer. Follow S 1015 for acceptance. Soil Embankment: 50 lb (23 kg) Granular Embankment: 50 lb (23 kg)	
258.02	Load Transfer Retrofit	Silicone Sealant– Obtain letter of certification stating that the material meets the requirements of Item 258. Material to be shipped from manufacturer not more than 9 months prior to use. Patching material - Verify brand name of material is on QPL at the time of use.	Notify District Testing if rejecting material. If material non-performs or looks defective during use submit a 1 quart sample to OMM.
304	Aggregate Base	Perform compaction conforming to S 1015 and 304.05 Products will be supplied by a S1069 Pre-Qualified Producer/Supplier. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use submit two 60 lb bag samples to OMM for testing.
305	PC Concrete Pavement Base	Make two 6"x6"x4' beams for every 7500 yd² (6500 m²) or fraction thereof daily. Field test beams for required load for the specification. Report results in SM.	Core samples taken every 2000 sq. yds by Contractor. Conform to S 1064.
407	Tack Coat	If obtaining a sample, draw at least 1 gallon from the sampling valve or tap and discard prior to obtaining a 1 quart sample. Tag and ship sample to the District lab for OMM Asphalt section testing. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use submit a 1 quart sample to OMM.
409	Sawing and Sealing Asphalt Concrete Pavement Joints	Inspect material for condition. Document in SM. Follow joint seal material sections for sampling and acceptance requirements.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
421	Microsurfacing Emulsion and Tack Coat	CSS-1hM: Certified Material per 702.16 Type C. See 702.16 section below. 421 Tack Coat per 421.09: At project sample per 421.12.A. Tag and ship sample to the District lab for OMM Asphalt section testing. Document in SM.	CSS-1hM: Certified material: Submit to OMM. Non-certified material: Submit to OMM. Do not use until approved. 421 Tack Coat per 421.09. Dilute per 421.09. Do not use non-certified material to dilute.
451, 452	PC Concrete Pavement	Make 6"x6"x4' beams for every 7500 yd² (6500 m²) or fraction thereof daily. Make two beams if testing before 7 days. Field test beams for required load for the specification. Report results in SM.	Core samples taken every 2000 yd by Contractor. Conform to S 1064.
451.09.B	Dowel Bond Breaking Material	Check new light form oil by labels on new cans. No sampling required	
499	Various Concrete Items	A sample for concrete strength testing consists of a set of three 4 × 8 inch cylinders when the maximum nominal aggregate is 1 inch or less. For concrete with maximum nominal aggregate sizes greater than 1 inch, a sample consists of a set of two 6 × 12 inch cylinders.	Once initial set has occurred, but no more than 48 hours after sampling, ship cylinders to District Testing with required documentation.
499.02	Water	Potable water is satisfactory. If question about water quality, obtain 1 gallon sample. Document in SM.	Notify District Testing if water appears to contain sewage, oil, acid, or other matter.
503.08	Excavation for Structures-	Sample only when requested by the Engineer per Item 203.	

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
	Backfill Material	Soil Embankment: 50 lb (23 kg) Granular Embankment: 50 lb (23 kg)	
507.09	Bearing Piles Steel Pile Points	Only use points from suppliers on the Approved List on the Office of Materials Management website. Document bearing piles in SM.	Notify District Testing if material non-performs or looks defective during use. Notify the contractor with non-compliance issues.
509.08	Reinforcing Steel - Plastic support chairs	Assure plastic supports conform to 709.15.	Maximum spacing of supports in slabs, beams and girders to be 4 feet or less to prevent substantial deflection.
511	Concrete for Structures	NON QC/QA SPECIFICATIONS Make one set of cylinders for spans over 20 ft each day, each 200 yd^3. For spans 20 ft span and under, make one set of cylinders each 50 yd^3 or less. Document in SM . Field or Standard Cure according to ACI/ODOT specifications. QC/QA SPECIFICATIONS Follow requirements of 455 for quality assurance sampling and testing. Document in SM.	Once initial set has occurred, but no more than 48 hours after sampling, ship cylinders to District Testing with required documentation. Once initial set has occurred, but no more than 48 hours after sampling, ship quality assurance cylinders to District Testing with required documentation.
515	Prestressed Concrete Bridge Members	Assure products are supplied by a source on the Certified List for S 1079 maintained by OMM. Receive with TE-24. Check dimension and condition Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM.
515.15	Prestressed Concrete Bridge Members - Corrosion Inhibitors	Verify company and brand name of material is on QPL at the time of use. Document in SM.	For precast beams delivered on TE-24, verification performed by OMM.
526	Approach Slabs	Make one set of cylinders for each day, each 200 yd^3. Document in SM. Field or Standard Cure according to ACI/ODOT specifications. QC/QA SPECIFICATIONS Follow requirements of 455 for quality assurance sampling and testing. Document in SM.	Once initial set has occurred, but no more than 48 hours after sampling, ship cylinders to District Testing with required documentation.
609.02	Curbing, Concrete Medians, and Traffic Islands - Stone Curbs	Contact District Testing and OMM to assure stone curb conforms to requirements of 609.02.	
610	Cellular Retaining Walls	610.04.A Cellular Products will be supplied by a source on the Certified Lists for S 1073 maintained by OMM. Receive with TE-24. Check dimension, condition and compliance with approved drawings. 610.04.B Cellular Products accept by certified test data documentation at the Project. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
613	Low Strength Mortar Backfill	Supplier to perform trial batches of 1 cy to ensure flowable consistency and yield. Refer to Item 613.05 for alternate mix design. Submit Alternate mix designs for approval 30 days prior to placement...When using foundry sand, obtain written permission from EPA ten days before use.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
632.11	Loop Detector Sealant	Verify manufacturer is on QPL. Inspect for condition, appearance and package markings. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
653.02	Topsoil	Obtain one (1) pint sample of material from each source and/or stockpile of visually different material from same source. Use friction top, air tight metal container supplied by the Department. Submit to Office of Geotechnical Engineering Operations. Samples will include a TE-31 form or SM print screen.	
657.02	RipRap for Tree Protection	Confirm with OMM that the aggregate source has an acceptable performance history. Sources with poor performance require test data conforming to ASTM D5240.	
658.02	Tree Root Aeration - Aggregate	Assure source is on the Certified List for S 1069 maintained by OMM. Assure aggregate meets soundness requirements. For sources with no soundness history, obtain a 100 lb (45 kg) sample.	
659.03	Liming Materials	Only accept materials from suppliers licensed in Ohio. See OMM website for list of Ohio Department of Agriculture list of licensed suppliers. Document in SM.	
659.04	Commercial Fertilizer	Only accept materials from suppliers licensed in Ohio. See OMM website for list of Ohio Department of Agriculture list of licensed suppliers. Inspect material for certified analysis and condition. Non-standard application rate requires approval prior to use. Document in SM .	Licensing is required. Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing & OMM.
659.07 659.08 659.09 S1022	Seeds Legumes Native Grasses and Wildflowers	Verify manufacturer is on Certified Supplier List maintained by OMM. Receive with TE-24 and description bill of lading. Document in SM .	Verify District approval of seed mixture.
659.14 659.15 659.16	Mulch	Material should be reasonably free from foreign matter that would inhibit seed germination.	Notify District Testing if rejecting material.
660.02	Sodding Materials	Verify company and brand name of material is on QPL at the time of use. Certification required for each shipment. Document in SM .	Notify District Testing if rejecting material.
661	Planting Trees Shrubs, Perennials and Vines	Only accept materials from licensed nurseries. See OMM website for list of Ohio Department of Agriculture list of licensed suppliers. Inspect material for condition. Plant material should be sealed until used. Document in SM .	Final acceptance should take place after period of establishment. Notify District Testing if rejecting material.
STANDARD MATERIALS SPECIFICATIONS			
701.01 701.02 701.04 701.05 701.07 701.09 701.15	Cement, Hydraulic ASTM Types I, IA, II, III,IL, Masonry Type IS(<25)	Verify manufacturer on Concrete Plant Batch Ticket is on Certified List for Supplement 1028 maintained by OMM. Verify material against bill of lading description. Document in SM.	

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
701.10	Micro-Silica	Verify manufacturer on Concrete Plant Batch Ticket is on Certified List for S 1045 maintained by OMM. Verify material against bill of lading description. Document in SM.	
701.11	Slag Cement	Verify manufacturer on Concrete Plant Batch Ticket is on Certified List for S 1034 maintained by OMM. Verify material against bill of lading description. Document in SM.	
701.13	Fly Ash/Natural Pozzolan	Verify manufacturer on Concrete Plant Batch Ticket is on Certified List for S 1026 maintained by OMM. Verify material against bill of lading description. Document in SM If high LOI fly ash verify manufacturer on Concrete Plant Batch Ticket is on List for S 1115.	
702.01	Asphalt Binder	Certified asphalt PG binder: As directed by OMM. Plant: Minimum of one sample per project per season, except for inconsequential quantities for each PG grade used. Non-Certified PG binder:Sample and Approve by OMM before use.	Certified binder: Plant: Submit sample to OMM. Non-certified binder: Submit to OMM. Do not allow asphalt production until material is approved.
702.02 702.03 702.04 702.07 702.12 702.13	Cut Back Asphalt Cut Back Asphalt Emulsions Emulsified Asphalts Asphalt Emulsion MWS Non-Tracking Asphalt Emulsion SBR Asphalt Emulsion	Certified material: At the refinery or source as directed by OMM. Project and/ or Plant: One sample per each 25,000 gallons. None for less than 300 gallons.. Non-certified material: Will be sampled and approved by OMM before use. 702.13 – Provide Certified Test Data per specification requirements.	Certified material: Submit to OMM. Non-certified material: Submit to OMM. Do not use until approved.
702.05 702.06	Asphalt Primer Waterproofing Asphalt Waterproofing	Verify type and brand name of material is on QPL at the time of use. Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Asphalt section.
702.08	Cold Liquid-Applied Elastomeric Waterproofing Membrane	Provide Certified Test Data per specification requirements.	
702.16	Polymer Emulsified Binder	Type A: Certified Material. At the refinery or source as directed by OMM. At project sample per 422.10 (once per day). Non-certified material is sampled and approved by OMM before use. Type B: Certified test data Type C: Certified Material. At the refinery or source as directed by OMM. At project sample per 421.12.A (once per day).	Type A and C: Certified material: Submit to OMM. Non-certified material: Submit to OMM. Do not use until approved.
702.17	Crack Sealant Type 1	Material is pre-tested and approved. Will be shipped with TE-24. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM Asphalt section.
	Type II	Provide fibers listed on the QPL. Provide PG64-22 conforming to 702.01.	Notify District Testing if rejecting material.

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
	Type III	Provide fibers listed on the QPL. Provide PG64-22 conforming to 702.01.	If material non-performs or looks defective during use notify District Testing and OMM Asphalt section.
	Type IV	Provide materials listed on the QPL.	
	Type V	Provide materials listed on the QPL.	
703.02 703.04 703.05 703.08	Coarse Aggregate	Coarse Aggregate will have current certification for use, and be supplied by a S1069 Pre-Qualified Producer/Supplier. Verify material certification, and Pre-Qualified status by checking SM or by using the CMRS portal and generating a report for that source or district. Document in SM.	60 to 75 lb. QA samples are taken by District Testing at each Pre-Qualified source a minimum of one (1) time per year. Sample at the project on an as needed basis to address material problems or risks associated with quality or gradation.
703.02 703.03 703.04 703.05 703.06 703.10	Fine Aggregate	Fine Aggregate will have current certification for use, and be supplied by a S1069 Pre-Qualified Producer/Supplier. Verify material certification, and Pre-Qualified status by checking SM or by using the CMRS portal and generating a report for that source or district. Document in SM.	30 to 40 lb. QA samples are taken by District Testing at each Pre-Qualified source a minimum of one (1) time per year. Sample at the project on an as needed basis to address material problems or risks associated with quality or gradation.
703.02 703.04 703.05	Dense Graded Aggregate	Dense Graded Aggregate will have current certification for use, and be supplied by a S1069 Pre-Qualified Producer/Supplier. Verify material certification, and Pre-Qualified status by checking SM or by using the CMRS portal and generating a report for that source or district. Document in SM.	90 to 100 lb. QA samples are taken by District Testing at each Pre-Qualified source a minimum of one (1) time per year. Sample at the project on an as needed basis to address material problems or risks associated with quality or gradation.
703.07	Materials Mineral filler	Limestone Dust will be supplied by a S1069 Pre-Qualified Producer/Supplier. Verify Pre-Qualified status by checking SM or by using the CMRS portal and generating a report for that source or district. For Portland cement assure source is on Certified list for S 1028. For inert mineral filler sample for gradation. Submit to District Testing.	
703.11 Type 1 Type 2 Type 3	Structural Backfill for 611 Bedding and Backfill	All 703.11 (Type 1, 2, & 3) shall be provided by a S1069 Pre-Qualified Producer/Supplier. Verify material certification, and Pre-Qualified status by checking SM or by using the CMRS portal and generating a report for that source or district. Document in SM.	40-100lb (depending on coarse, fine, or dense grade) QA samples are taken by District Testing at each Pre-Qualified source a minimum of one (1) time per year. Sample at the project on an as needed basis to address material problems or risks associated with quality or gradation.
703.13	Coarse Aggregate for Items 451 and 452	All materials shall be provided by a S1069 Pre-Qualified Producer/Supplier. Verify material certification, and Pre-Qualified status by checking SM or by using the CMRS portal and generating a report for that source or district. Document in SM.	240-300 lb QA (Freeze Thaw/Quality) samples are taken by District Testing once (1) every 2 to 4 years depending on certification and submitted to OMM for testing **(this is additional to standard coarse aggregate testing).** Sample at the project on an as needed basis to address material problems or risks associated with quality or gradation.
703.14	Steel Slag Aggregate for Non-Pavement Use	All materials shall be provided by a S1069 Pre-Qualified Producer Supplier. Stockpile and sample each 2500 tons (2300 metric tons). Notify the District laboratory for inspection of sources and to obtain split samples. Test for expansion. Document in SM.	Steel Slag less than 10 yrs old requires X-Ray Fluorescence for total percent MgO, and X-Ray Diffraction for total percent periclase. Sample at the project on an as needed basis to address material problems or risks associated with quality or gradation.

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
703.16	Suitable Materials for Embankment Construction	All materials shall be provided by a S1069 Pre-Qualified Producer/Supplier. Multiple aggregate types available. Follow the requirements of the individual material specification. Verify material certification, and Pre-Qualified status by checking SM or by using the CMRS portal and generating a report for that source or district. Document in SM.	Sample at the project on an as needed basis to address material problems or risks associated with quality or gradation.
703.17	Dense Graded Aggregate for Item 304	All materials shall be provided by a S1069 Pre-Qualified Producer/Supplier. Verify the material certification, and Pre-Qualified status by checking SM or by using the CMRS portal and generating a report for that source or district.	90 to 100 lb. QA sample taken by District Testing at each source a minimum of (1) time per year. Sample at the project on an as needed basis to address material problems or risks associated with quality or gradation.
703.18	Aggregate for Items 410, 411, and 617	All materials shall be provided by a S1069 Pre-Qualified Producer/Supplier. Verify the material certification, and Pre-Qualified status by checking SM or by using the CMRS portal and generating a report for that source or district.	90 to 100 lb. QA sample taken by District Testing at each source a minimum of (1) time per year. Sample at the project on an as needed basis to address material problems or risks associated with quality or gradation.
703.19.A	Crushed Aggregate Slope Protection and Filter Aggregate for Dump Rock Fill	All materials shall be provided by a S1069 Pre-Qualified Producer/Supplier. Verify the material certification, and Pre-Qualified status by checking SM or by using the CMRS portal and generating a report for that source or district.	Sample and/or photograph with a scale for sizing on an as needed basis to address material problems or risks associated with quality or gradation.
703.19.B	Dumped Rock Fill and Rock Channel Protection	All materials shall be provided by a S1069 Pre-Qualified Producer/Supplier. Verify the material certification, and Pre-Qualified status by checking SM or by using the CMRS portal and generating a report for that source or district.	Sample and/or photograph with a scale for sizing on an as needed basis to address material problems or risks associated with quality or gradation.
704.01 704.02 704.03	Block: Brick Concrete Masonry Shale	Verify type of material is on QPL at the time of use. Inspect for condition and defects. Document in SM .	Notify District Testing if rejecting material. When material non-performs or looks defective during use reject material and sample 12 pieces representative of defect to OMM for QA follow-up.
705.01	Glass Fiber Reinforced Polymer (GFRP) Dowel and Deformed Bars	Certified test data from an accredited testing facility will accompany each shipment. Document in SM.	Notify District Testing upon receipt of shipment.
705.03	Joint Filler Preformed	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, appearance and dimension. Document in SM .	Notify District Testing if rejecting material. If material non-performs or looks defective during use send one (1) 1.5'x2.5' sample representative of defect to OMM for QA follow-up.
705.04	Joint and Crack Sealer Hot Applied	Material is pre-tested and approved. Will be shipped with TE-24. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM Asphalt section for sampling requirements.
705.05	Burlap Cloth Materials	Inspect for condition, appearance and dimension. Documenting in SM is not required. Sample only if there is a question that material meets specification.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
705.06	Sheet Curing Materials	Inspect for condition, appearance and dimension. Documenting in SM is not required.	Notify District Testing if rejecting material.

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
		Sample only if there is a question that material meets specification.	If material non-performs or looks defective during use notify District Testing and OMM.
705.07	Concrete Curing Compounds	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and appearance. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use send one (1) quart sample representative of defect to OMM Cement and Concrete section for QA follow-up.
705.10	Air Entraining Admixtures	Verify type and brand name of material listed on Concrete Plant Batch Ticket is on QPL at the time of use. Document in SM.	Storage: Admixtures should be stored at concrete producer in such a manner to permit easy access for proper identification in weather resistant units. Provide minimum QA sample of one (1) annually per concrete plant, each material, each company. Minimum sample size one (1) quart.
705.11	Preformed Elastomeric Joint Sealer	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, appearance, dimension and manufacturer trademark. Document in SM .	Notify District Testing if rejecting material because material non-performs or looks defective during use.
705.12	Chemical Admixtures for Concrete	Verify type and brand name of material is on QPL at the time of use. Document in SM.	Storage: Admixtures should be stored at concrete producer in such a manner to permit easy access for proper identification in weather resistant units. Provide minimum QA sample of one (1) annually per concrete plant, each material, each company. Minimum sample size one (1) quart.
705.13	Neoprene Sheeting	Verify type and brand name of material is on QPL at time of use. Inspect for condition and appearance. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section, if rejecting material because material non-performs or looks defective during use.
705.15	High Molecular Weight Methacrylate (HMWM)	Verify type and brand name of material is on QPL at the time of use. Document in SM.	
705.20	Non Shrink, Non Metallic Materials	Verify type and brand name of material is on QPL at the time of use. Ensure mixing is performed in accordance with manufacturer's recommendations on the container. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM for sampling requirements.
705.21	Quick Setting Concrete Mortar	Verify type and brand name of material is on QPL at the time of use. Ensure mixing is performed in accordance with manufacturer's recommendations on the container. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM for sampling requirements.
705.22	Non-shrink Mortar	Verify manufacturer is on the Approved List maintained by OMM. Ensure mixing is performed in accordance with manufacturer's recommendations on the container. Make three (3) or more 3"x6" cylinders from keyway mix. Ship to OMM Concrete Section. Document in SM.	Sample will be tested at 3, 7 and 28 days. Do not open structure to traffic until a compressive strength of 5000 psi (34.5 MPa) is achieved.

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
705.23 A	Epoxy-urethane Sealers	Verify type and brand name of material is on QPL at the time of use. Ensure mixing is performed in accordance with manufacturer's recommendations on the container. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use obtain 1 qt (1 L) samples in a sealed container and send to OMM.
705.23 B	Non Epoxy Sealers	Verify type and brand name of material is on QPL at the time of use. Ensure mixing is performed in accordance with manufacturer's recommendations on the container. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use obtain 1 qt (1 L) samples in a sealed container and send to OMM.
705.24	Soluble Reactive Silicate	Verify type and brand name of material is on QPL at the time of use. Ensure mixing is performed in accordance with manufacturer's recommendations on the container. Document in SM.	Notify District Testing if rejecting material.
705.25	Gravity Fed Resin	Verify type and brand name of material is on QPL at the time of use. Ensure mixing is performed in accordance with manufacturer's recommendations on the container. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use obtain 1 qt (1 L) samples in a sealed container and send to OMM.
705.26	Epoxy injection Resin	Verify type and brand name of material is on QPL at the time of use. Make sure that ports are properly installed and ensure mixing is performed in accordance with manufacturer's recommendations Document in SM.	Notify District Testing if rejecting material.
705.27	Carbonate Micro-fines	Verify manufacturer on Concrete Plant Batch Ticket is on Certified List for S 1016 maintained by OMM. Verify material against bill of lading description. Document in SM	
705.28	Glass Fiber Reinforced Polymer (GFRP) Deformed Bars	Products will be supplied by a source on the Certified List for S 1138 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section, if rejecting material because material non-performs or looks defective during use. Obtain three (3) 30" long samples of each reinforcement size, with markings, and submit for QA testing by the Laboratory.
706.01	Non-Reinforced Concrete Pipe	Assure products are supplied by a source on the Certified List for S 1074 maintained by OMM. Receive with TE-24. Check dimension, markings, roughness or excessive cracks. Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Cement and Concrete section.
706.02	Reinforced Concrete Circular Pipe	Assure products are supplied by a source on the Certified List for S 1074 maintained by OMM. Receive with TE-24. Check dimension, markings, roughness or excessive cracks. Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Cement and Concrete section.
706.03	Reinforced Concrete Pipe, Epoxy Coated	Assure products are supplied by a source on the Certified List for S 1074 maintained by OMM. Receive with TE-24. Check dimension, markings, roughness or excessive cracks. Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Cement and Concrete section.

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
706.04	Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe	Assure products are supplied by a source on the Certified List for S-1074 maintained by OMM. Received with TE-24. Check dimension, markings, roughness or excessive cracks. Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Cement and Concrete section.
706.05	Precast Reinforced Concrete Box Sections	Assure products are supplied by a source on the Certified List for S 1073 maintained by OMM. Receive with TE-24. Check dimension, markings, roughness or excessive cracks. Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Cement and Concrete section.
706.051	Precast Reinforced Concrete Three-Sided Flat Topped Culverts	Assure products are supplied by a source on the Certified List for S 1073 maintained by OMM. Receive with TE-24. Check dimension, markings, roughness or excessive cracks. Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Cement and Concrete section.
706.052	Precast Reinforced Concrete Arch Sections	Assure products are supplied by a source on the Certified List for S 1073 maintained by OMM. Receive with TE-24. Check dimension, markings, roughness or excessive cracks. Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Cement and Concrete section.
706.053	Precast Reinforced Concrete Round Sections	Assure products are supplied by a source on the Certified List for S 1073 maintained by OMM. Receive with TE-24. Check dimension, markings, roughness or excessive cracks. Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Cement and Concrete section.
706.06	Perforated Concrete Pipe	Assure products are supplied by a source on the Certified List for S 1074 maintained by OMM. Receive with TE-24. Check dimension, markings, roughness or excessive cracks. Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Cement and Concrete section.
706.07	Concrete Drain Tile	Assure products are supplied by a source on the Certified List for S 1074 maintained by OMM. Receive with TE-24. Check dimension, markings, roughness or excessive cracks. Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Cement and Concrete section.
706.08	Vitrified Clay Pipe	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, appearance and dimension. Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Cement and Concrete section.
706.09	Clay Drain Tile	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, appearance and dimension. Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Cement and Concrete section.
706.10	Asphalt pipe joint filler	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, appearance and dimension. Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Asphalt section.

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
706.11	Resilient and Flexible Gasket Joints	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, appearance and dimension. Document in SM .	Notify District Testing and OMM Cement and Concrete section, if rejecting material because material non-performs or looks defective during use.
706.12	Resilient and Flexible Joints	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, appearance and dimension. Document in SM .	Notify District Testing and OMM Cement and Concrete section, if rejecting material because material non-performs or looks defective during use.
706.13	Precast Reinforced Concrete Manhole Riser Sections, Catch Basins and Inlet Tops, and Temporary Barriers	Assure products are supplied by a source on the Certified List for S 1073 maintained by OMM Receive with TE-24. Check dimension, markings, roughness or excessive cracks. Document in SM.	Notify District Testing and OMM Cement and Concrete section, if rejecting material because material non-performs or looks defective during use.
706.14	Flexible Plastic Gaskets	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, appearance and dimension. Document in SM .	Notify District Testing and OMM Cement and Concrete section, if rejecting material because material non-performs or looks defective during use.
706.15	Precast Reinforced Concrete Outlets	Assure products are supplied by a source on the Certified List for S 1073 maintained by OMM Receive with TE-24. Check dimension, markings, roughness or excessive cracks. Document in SM.	Notify District Testing and OMM Cement and Concrete section, if rejecting material because material non-performs or looks defective during use.
707.01	Metallic Coated Corrugated Steel Conduits and Underdrains [½ inch and 1/4 depth corrugations]	Products will be supplied by a source on the Certified List for S 1019 maintained by OMM. Receive with TE-24. Check dimensions and markings. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.02	Metallic Coated Corrugated Steel Conduits [1 inch depth corrugation]	Products will be supplied by a source on the Certified List for S 1019 maintained by OMM. Receive with TE-24. Check dimensions and markings. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.03	Structural Plate Corrugated Steel Structures	Products will be supplied by a source on the Certified List for S 1019 maintained by OMM. Receive with TE-24. Check dimensions and markings. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.04	Precoated, Galvanized Steel Culverts	Products will be supplied by a source on the Certified List for S 1019 maintained by OMM. Receive with TE-24. Check dimensions and cracks. Document inSM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.05 705.07	Bituminous Coated Corrugated Steel Pipe and Arches with Paved Invert [½ inch depth corrugations] [1 inch depth corrugations]	Products will be supplied by a source on the Certified List for S 1019 maintained by OMM. Receive with TE-24. Check dimensions and markings. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.10	Steel Tubing Square and Rectangular	Generally a fabricated component received with TE-24. Check dimensions and markings. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
707.11	Polymer-precoated corrugated steel spiral rib pipe	Products will be supplied by a source on the Certified List for S 1019 maintained by OMM. Receive with TE-24. Check dimensions and markings. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.12	Corrugated Steel Spiral Rib Conduits	Products will be supplied by a source on the Certified List for S 1019 maintained by OMM. Receive with TE-24. Check dimensions and markings. Document in SM	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use
707.13 707.14	Bituminous Lined Corrugated Steel Pipe [½ depth corrugations] [1 depth corrugations]	Products will be supplied by a source on the Certified List for S 1019 maintained by OMM. Receive with TE-24. Check dimensions and markings. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.15	Corrugated Steel Box Culverts	Products will be supplied by a source on the Certified List for S 1019 maintained by OMM. Receive with TE-24. Check dimensions and markings. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.18	Polymer Precoated, Galvanized Steel Conduits with precoated galvanized smooth steel interior liner	Products will be supplied by a source on the Certified List for S 1019 maintained by OMM. Receive with TE-24. Check dimension and markings. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.19	Aluminum Coated Steel Conduits with precoated galvanized smooth steel interior liner	Products will be supplied by a source on the Certified List for S 1019 maintained by OMM. Receive with TE-24. Check dimension and markings. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.20	Galvanized Coated Steel Conduits with precoated galvanized smooth steel interior liner	Products will be supplied by a source on the Certified List for S 1019 maintained by OMM. Receive with TE-24. Check dimension and markings. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.21	Corrugated Aluminum Alloy Conduits and Underdrains [1/4, 7/16 & ½ inch depth corrugations]	Products will be supplied by a source on the Certified List for S 1019 maintained by OMM. Receive with TE-24. Check dimension and markings. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.22	Corrugated Aluminum Alloy Conduits	Products will be supplied by a source on the Certified List for S 1019 maintained by OMM. Receive with TE-24. Check dimension and markings. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.23	Aluminum Alloy Structural Plate Conduits	Products will be supplied by a source on the Certified List for S 1019 maintained by OMM. Receive with TE-24. Check dimensions and markings. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.24	Corrugated Aluminum Spiral Rib Conduits	Products will be supplied by a source on the Certified List for S 1019 maintained by OMM. Receive with TE-24. Check dimensions and markings. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
707.25	Corrugated Aluminum Box Culverts	Products will be supplied by a source on the Certified List for S 1019 maintained by OMM. Receive with TE-24. Check dimensions and markings. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.31 707.32 707.33	Polyethylene Corrugated Pipe	Products will be supplied by a source on the Certified List for S 1066 maintained by OMM. Receive with TE-24. Check dimension and markings. Document in SM..	Notify District Testing and OMM Asphalt section, if rejecting material because material non-performs or looks defective during use.
707.34 707.35	Polyethylene Pipe-Outside Diameter Polyethylene Profile Wall Pipe	Signed Letter of Certification from Supplier	Notify District Testing and OMM Structural Welding and Metals section, if rejecting material because material non-performs or looks defective during use.
707.41	Smooth-Wall Polyvinyl Chloride Underdrain Pipe	Verify type and brand name of material is on QPL at the time of use. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.42	Polyvinyl Chloride Corrugated Smooth Interior Pipe	Verify type and brand name of material is on QPL at the time of use. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.43	Polyvinyl Chloride Profile Wall Pipe	Verify type and brand name of material is on QPL at the time of use. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.45	Polyvinyl Chloride Solid Wall Pipe	Verify type and brand name of material is on QPL at the time of use. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.46	Polyvinyl Chloride Drain Waste and Vent Pipe	Verify type and brand name of material is on QPL at the time of use. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.47	ABS and Polyvinyl Chloride Composite Pipe	Furnish certified test data conforming to 101.03 to the Engineer. Document in SM. Accept based on inspection of material for type, condition, dimension, receipt and verification of manufacturer's certified test data.	Notify District Testing if rejecting material.
707.48	Polyvinyl Chloride Large-Diameter Solid Wall Pipe	Verify type and brand name of material is on QPL at the time of use. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.51	ABS Drain Waste and Vent Pipe	Furnish certified test data conforming to 101.03 to the Engineer. Document in SM. Accept based on inspection of material for type, condition, dimension, receipt and verification of manufacturer's certified test data.	Notify District Testing if rejecting material.
707.52	ABS Sewer Pipe	Furnish certified test data conforming to 101.03 to the Engineer. Document in SM. Accept based on inspection of material for type, condition, dimension, receipt and verification of manufacturer's certified test data.	Notify District Testing if rejecting material.

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
707.65	Corrugated Polypropylene Smooth Lined Pipe	Products will be supplied by a source on the Certified List for SS-1066 maintained by OMM. Received with TE-24 Check dimension, marking and condition. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.70	Welded and Seamless Steel Pipe	Verify type and brand name of material is on QPL at the time of use. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.80	Reinforced Thermosetting Resin Pipe	Accept based on inspection of material for type, condition, dimension, receipt and verification of manufacturer's certified test data. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
707.85	Steel Reinforced Thermoplastic Ribbed Pipe	Accept based on inspection of material for type, condition, dimension, receipt and verification of manufacturer's certified test data. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
708.01	Inorganic Zinc Silicate Primer Paint	Products will be supplied by a source on the Certified List for S 1084 maintained by OMM. Verify type and brand name of material is on QPL at the time of use. Inspect material container for markings, expiration date and condition. Document in SM.	Notify District Testing and OMM Chemical section, if rejecting material because material non-performs or looks defective during use. Obtain a 1 qt (1 L) sample representative of the defects.
708.02 708.02B 708.02C 708.02D	OZEU Structural Steel Pant Organic Zinc Prime Coat Epoxy Intermediate Coat Urethane Finish Coat	Products will be supplied by a source on the Certified List for S 1084 maintained by OMM. Verify type and brand name of material is on QPL at the time of use. Inspect material container for markings, expiration date and condition. Document in SM.	Notify District Testing and OMM Chemical section, if rejecting material because material non-performs or looks defective during use. Obtain a 1 qt (1 L) sample representative of the defects.
709.00	Epoxy Coated Steel Reinforcement	Products will be supplied by a source on the Certified List for S 1068 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Structural Welding and Metals section and obtain three (3) 30" long samples of each reinforcement size, with markings, and submit for QA testing by the Laboratory.
709.01	Deformed and Plain Billet Steel Bars for Concrete Reinforcement	Products will be supplied by a source on the Certified List for S 1068 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Structural Welding and Metals section and obtain three (3) 30" long samples of each reinforcement size, with markings, and submit for QA testing by the Laboratory.
709.03	Rail Steel Deformed and Plain Bars for Concrete Reinforcement	Products will be supplied by a source on the Certified List for S 1068 maintained by OMM. Receive with TE-24. Check dimension, markings and condition.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Structural Welding and Metals

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
		Document in SM.	section and obtain three (3) 30" long samples of each reinforcement size, with markings, and submit for QA testing by the Laboratory.
709.05	Axle Steel Deformed and Plain Bars for Concrete Reinforcement	Products will be supplied by a source on the Certified List for S 1068 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Structural Welding and Metals section and obtain three (3) 30" long samples of each reinforcement size, with markings, and submit for QA testing by the Laboratory.
709.08	Cold-Drawn Steel Wire for Concrete Reinforcement	Products will be supplied by a source on the Certified List for S 1068 maintained by OMM. Received with TE-24. Check dimension, markings and condition. Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Structural Welding and Metals section and obtain three (3) 30" long samples of each reinforcement size, with markings, and submit for QA testing by the Laboratory.
709.09	Fabricated Steel Bar or Rod Mats for Concrete Reinforcement	Products will be supplied by a source on the Certified List for S 1068 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document in SM	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Structural Welding and Metals section and obtain three (3) 30" long samples of each reinforcement size, with markings, and submit for QA testing by the Laboratory.
709.10	Welded Steel Wire Fabric for Concrete Reinforcement	Products will be supplied by a source on the Certified List for S 1068 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document in SM .	Notify District Testing and OMM Structural Welding and Metals section. Obtain 3 ft x 3 ft (1 m x 1 m) of the mat and submit for QA testing by OMM.if rejecting material because material non-performs or looks defective during use.
709.11	Deformed Steel Wire for Concrete Reinforcement	Products will be supplied by a source on the Certified List for S 1068 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document inSM.	Notify District Testing and OMM Structural Welding and Metals section. Obtain 3 ft x 3 ft (1 m x 1 m) of the mat and submit for QA testing by OMM.if rejecting material because material non-performs or looks defective during use.
709.12	Welded Deformed Steel Wire Fabric for Concrete Reinforcement	Products will be supplied by a source on the Certified List for S-1068 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section. Obtain 3 ft x 3 ft (1 m x 1 m) of the mat and submit for QA testing by OMM.if rejecting material because material non-performs or looks defective during use.
709.13	Coated Dowel Bars	Products will be supplied by a source on the Certified List for S-1068 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section. Obtain 3 dowel bars and submit for QA testing by the Laboratory. if rejecting material because material non-performs or looks defective during use.

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
709.14	Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement	Products will be supplied by a source on the Certified List for S-1068 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section. Obtain 3 ft x 3 ft (1 m x 1 m) of the mat and submit for QA testing by OMM.if rejecting material because material non-performs or looks defective during use.
709.15	Plastic Supports for Reinforcing Steel	Products will be supplied by a source on the Approved List maintained by OMM. Inspect for dimension and condition.	Notify District Testing if rejecting material that non-performs or looks defective during use.
709.16	Galvanizing Steel Reinforcement	Products will be supplied by a source on the Certified List for S 1068 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Structural Welding and Metals section and obtain three (3) 30" long samples of each reinforcement size, with markings, and submit for QA testing by the Laboratory.
709.17	Chromium Steel Reinforcement	Products will be supplied by a source on the Certified List for S 1068 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Structural Welding and Metals section and obtain three (3) 30" long samples of each reinforcement size, with markings, and submit for QA testing by the Laboratory.
709.18	Stainless Steel Reinforcement	Products will be supplied by a source on the Certified List for S 1068 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Structural Welding and Metals section and obtain three (3) 30" long samples of each reinforcement size, with markings, and submit for QA testing by the Laboratory.
709.19	Mechanical Splice Systems	Products will be supplied by a source on the Certified List for S 1134 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document in SM.	If rejecting material because material non-performs or looks defective during use, notify District Testing and OMM Structural Welding and Metals section; and obtain two samples of each mechanical splice and (2) 30" long samples of each reinforcement size, with markings, and submit for QA testing by the Laboratory.
710.01.A 710.01 B	Barbed Wire	Products will be supplied by a source on the Certified List for S 1067 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use and obtain a 5 ft (1.5 m) length of barbed wire and submit for QA testing by the Laboratory.
710.02	Woven Steel Wire Fence, Type 47	Products will be supplied by a source on the Certified List for S 1067 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use and obtain 4 ft (1.2 m) width of

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
			fencing and submit for QA testing by the Laboratory.
710.03	Chain-Link Fence [including Fittings and Accessories]	Products will be supplied by a source on the Certified List for S 1067 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document in SM.	If rejecting material because material non-performs or looks defective during use notify District Testing and OMM Structural Welding and Metals section, and obtain samples as directed by the Laboratory.
710.06	Deep Beam Rail	Products will be supplied by a source on the Certified List for S 1042 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during us and obtain a section of guardrail, three (3) 1 ft (0.3 m) long then submit for QA testing by the Laboratory.
710.09	Wire Rope Rail	Inspect for dimension, condition, appearance and markings on tag or reel. Submit one (1) six (6) ft. sample to OMM. Document in SM	Approval required prior to use. Notify District Testing and OMM.
710.11	Fence Posts and Braces [Lumber] [Steel]	Products will be supplied by a source on the Certified List for S 1067 and S 1072 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
710.12	Square-Sawed and Round Guardrail Posts	Products will be supplied by a source on the Certified List for S 1042 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
710.14	Pressure Treated Guardrail and Fence Posts, Braces, and Blocks	Products will be supplied by a source on the Certified List for S 1042 and S 1067 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document in SM.	Notify District Testing and OMM Structural Welding and etals section if rejecting material because material non-performs or looks defective during use.
710.15	Steel Guardrail Posts	Products will be supplied by a source on the Certified List for S 1042 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
710.16	Guard Posts	Products will be supplied by a source on the Certified List for S 1042 and S 1067 maintained by OMM. Receive with TE-24. Check dimension, markings and condition. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
711.01	Structural Steel	Material supplied by a Fabricator source on the Certified List for Items 513, 516, 517 & 518 maintained by OMM. Structural Steel Members are received with TE-24.	If questions concerning structural steel materials, contact OMM Structural Steel Section and notify District Testing.
711.02	Galvanized Steel	Any material supplied with galvanizing will conform to this specification. Randomly inspect galvanizing for appearance and thickness of coating.	Notify District Testing if rejecting material.
711.03	Steel for Sheet Piling	Certified Mill Test Data required for new material. Verify tensile and chemical properties meet requirements.	

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
		Inspect all material for dimension and condition. Used material is not acceptable for permanent installations. Document field inspection.	
711.04	Cold Rolled Steel	Contact OMM Structural Steel section for acceptance process. Document in SM.	Notify District Testing and OMM Structural Steel Section section if rejecting material.
711.07	Steel Castings	Contact OMM Structural Steel section for acceptance process. Document in SM.	Notify District Testing and OMM Structural Steel Section section if rejecting material.
711.08	Arc-welding Electrode & Fluxes	Verify manufacturer is on Approved List maintained by OMM. Inspect for dimension, condition and markings.	If material is not on Approved List, certification and test data from supplier will be submitted to OMM. Do not use until approval has been received.
711.09	High Strength Bolts Nuts and Washers	Receive with TE-24. Inspect material for dimension, condition and markings. Reject defective material. Perform field testing of assembly combination per S 1080. Document field inspection & testing in SM.	If field test does not meet requirements of S 1080, retest bolt, nut and washer combination after application of a lubricant. Notify District Testing if rejecting material.
711.10	Machine Bolts	General specification for many common bolts Verify material is component of certified supplier shipment like S1042 for Guardrail Suppliers or S1067 for Fence Suppliers. Inspect for condition and coating. Reject defective material.	Notify District Testing if rejecting material.
711.12 711.13 711.14	Gray Iron Castings Ductile Iron Castings Gray Iron & Ductile Iron Castings	Verify manufacturer is on Approved List maintained by OMM. Receive with TE-24. Inspect for condition and defect. Document in SM.	Notify District Testing if rejecting material.
711.15 711.16 711.17 711.18 711.19	Sheet Copper Phosphor Bronze Plate Cast Bronze Leaded Bronze Sheet Lead	Material supplied by a Fabricator source on the Certified List for Items 513, 516, 517 & 518 maintained by OMM. Structural Steel Members are received with TE-24. Document in SM.	If questions concerning structural steel materials, contact OMM Structural Steel section and notify District Testing.
711.20	Aluminum for Railings	Material supplied by a Fabricator source on the Certified List for Items 513, 516, 517 & 518 maintained by OMM. Structural Steel Members are received with TE-24. Document in SM.	If questions concerning structural steel materials, contact OMM Structural Steel Section and notify District Testing.
711.21	Preformed Bearing Pads	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in SM.	If material non-performs or looks defective during use notify District Testing and OMM.
711.22	Buried Liner Waterproofing Membrane	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defects. Verify dimension conform to plan requirements. Document in SM.	If material non-performs or looks defective during use notify District Testing and OMM.
711.23	Elastomeric Bearings	Only accept elastomeric bearings shipped by TE-24.and provided by certified suppliers conforming to S1081. Notify district testing. to Inspect material to check location and number of internal shims utilizing an ice pick or similar tool.	Field acceptable for durometer. Reading average range: +/- 7 points of design plan number.

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
		Five (5) Durometer Gage readings should be taken and averaged to determine compliance with design plans. Document in SM.	
711.24	Waterproofing fabric	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in SM.	Notify District Testing if rejecting material.
711.25	Type 2 Membrane Waterproofing	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use send one (1) 4 ft^2 sample representative of defect to OMM for QA follow-up.
711.26	Structural Timber, Lumber and Piling	Products will be supplied by a source on the Certified List for S1072 maintained by OMM. Received with TE-24 and supplier bill of lading. Check dimension, quantity and condition. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section, if rejecting material because material non-performs or looks defective during use.
711.27	Prestressing Steel	Material supplied by a Fabricator source on the Certified List for Items 515 maintained by OMM. Prestressed Concrete Members are received with TE-24.	If questions concerning prstressed concrete or prestressed
711.28	Cellular Polyvinyl Chloride Sponge	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use send one (1) 1.5'x2.5' sample representative of defect to OMM for QA follow-up.
711.29	Type 3 Membrane Waterproofing	Verify type and brand name of material is on QPL at the time of use. Membrane primer is 705.04 material Inspect for condition and defect. Verify dimension conform to plan requirements. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use send one (1) 4 square ft sample representative of defect to OMM for QA follow-up.
711.30	Aluminum for Steps	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
711.31	Reinforced Propylene Plastic Manhole Steps	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
712.01	Expansion Shield Anchors	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use and send three(3) samples representative of defect to OMM for QA follow-up.
712.02	Calcium Chloride	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use contact OMM.

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
712.03	Sodium Chloride	Inspect material for condition. Submit one (1) pint sample per each Purchase Order to OMM. Document in SM.	If additional samples required for material quantities exceeding 3000 tons, notify District Testing.
712.04 A	Lime [masonry]	Sample & Inspect material for condition with 24 hrs of receipt. One (1) five (5) lb sample. Document in SM.	Notify District Testing if rejecting material.
712.04 B	Lime [Quick] for Stabilization	Assure provided material is from suppliers certified under S 1087 and listed on the Departments QPL. Inspection for condition and defects Document in SM. If questions on material quality sample one (1) ten (10) lb sample of Quicklime. Send to Geotechnical Engineering.	Notify District Testing if rejecting material. Samples may be taken in triplicate, if required. Contact Geotechnical Engineering.
712.04 C	Lime Kiln Dust	Assure provided material is from suppliers certified under S1087 and documentation for S1087 is complete. Document in SM If questions on material quality, sample one (1) ten (10) lb sample of Lime Kiln Dust. Send to Geotechnical Engineering	Notify District Testing if rejecting material. Samples may be taken in triplicate, if required. Contact Geotechnical Engineering.
712.06	Preservative Treatment for Structural Timber	Component material of pressure treated lumber. No approval required. Approval is for the wood including the preservative treatment	If questions on pressure treated lumber check the specific material item and follow those instructions.
712.09	Geotextile Fabrics	Verify type and brand name of material is on Approved List at the time of use. Inspect for condition and defect. Verify dimensions conform to plan requirements. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use submit one (1) 4' x 4' sample representative of defect to OMM.
712.10	Prefabricated Edge Underdrain	Inspect material for condition and dimension. Manufacturer's certified test data required for acceptance. Document in SM.	Notify District Testing if rejecting material.
712.11	Temporary Erosion Control Mats Material [Types A through I]	Inspect material for condition and dimension. Field Acceptance item.	Notify District Testing if rejecting material.
712.12	Tied Concrete Block Mat	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimensions conform to plan requirements. Document in SM.	Notify District Testing and OMM Concrete section, if rejecting material because material non-performs or looks defective during use.
712.13	Articulating Concrete Block Revetment System	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimensions conform to plan requirements. Document in SM.	Notify District Testing and OMM Concrete section, if rejecting material because material non-performs or looks defective during use.
712.14	Detectable Warning Device	Verify type and brand name of material is on Approved List at the time of use. Inspect for condition and defect. Verify dimensions conform to plan requirements. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use.
712.15	Geogrids	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimensions conform to plan requirements. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use submit one (1) 4' x 4' sample representative of defect to OMM
712.16	Prefabricated Geocomposite Drain (PGD)	Use if certification provided meets or exceeds tables in 712.16. .	Notify District Testing if rejecting material.

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
		Document in SM.	If material non-performs or looks defective during use notify District Testing and OMM.
720.01	Rectangular Reflectors	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, color requirements and defect. Verify dimension conform to plan requirements. Document in SM.	Notify District Testing and OMM Chemical section, if rejecting material because material non-performs or looks defective during use.
720.03	Flexible Delineator Posts	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in SM.	Notify District Testing and OMM Chemical section if rejecting material because material non-performs or looks defective during use.
721.01	Raised Pavement Marker Castings	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify type conforms to pre-qualification requirements. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use and obtain one (1) 4x2x0.48 in. sample representative of defect to OMM for QA follow-up.
721.02	Prismatic Retroreflector and Adhesive	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify type conforms to pre-qualification requirements. Document in SM.	Notify District Testing and OMM Structural Welding and Metals section if rejecting material because material non-performs or looks defective during use and obtain one (1) sample representative of defective RPM casting to OMM for QA follow-up.
721.03	Casting Adhesive	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in SM.	Notify District Testing and OMM Chemical section if rejecting material because material non-performs or looks defective during use.
725.02	Wire and Cables	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, markings and conformance to plan requirements. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use send a sample representative of non -compliance or defect to OMM for QA follow-up.
725.03	Unit Type Duct-Cable Systems	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, markings and conformance to plan requirements. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use send a 10 ft. sample representative of non -compliance or defect to OMM for QA follow-up.
725.04	Rigid Ferrous Metal Electrical Conduit and Fittings	Verify type and brand name of material is on QPL at the time of use. Inspect for condition of coating and conformance to plan requirements. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use send a sample representative of non -compliance or defect to OMM for QA follow-up.
725.051	Polyvinyl Chloride Conduit and Fittings	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, markings and conformance to plan requirements. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use send a sample representative of non -compliance or defect to OMM for QA follow-up.

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
725.052	Polyethylene Conduit and Fittings	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, markings and conformance to plan requirements. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use send a sample representative of non -compliance or defect to OMM for QA follow-up.
725.06	Polymer Concrete Pull Boxes	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, markings and conformance to plan requirements. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use send a sample representative of non -compliance or defect to OMM for QA follow-up.
725.07	Plastic Pull Box	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, markings and conformance to plan requirements. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.08	Portland Concrete Pull Boxes	Products will be supplied by a source on the Certified List for S 1073 maintained by OMM. Receive with TE-24. Check dimension, markings, roughness or excessive cracks. Item 604 Installation documented on CA-P-3 Inspection Form. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.10	Junction Boxes	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, markings and conformance to plan requirements. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.11 B	Lamps for Luminaires	Inspect for condition, markings and conformance to plan requirements. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.11 E	Conventional Luminaires for High Intensity Discharge Lamps (including Optical system, lamp, ballast and housing)	Inspect for condition, dimension, markings and conformance to plan requirements. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.11 F	Wall Mounted Underpass Luminaires (including Optical system, lamp, ballast and housing)	Inspect for condition, dimension, markings and conformance to plan requirements. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.11 G	High Mast/Low Mast Luminaire (including Optical system, lamp, ballast and housing)	Inspect for condition, dimension, markings and conformance to plan requirements. Document in SM..	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.12	Polyethylene, Fiberglas reinforced, Pull Box with Polymer concrete cover and support ring	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, markings and conformance to plan requirements. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.15B	Fused Pull-Apart Connection	Verify type and brand name of material is on QPL at the time of use.	Notify District Testing if rejecting material.

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
		Inspect for condition, dimension, markings and conformance to plan requirements. Document in SM.	If material non-performs or looks defective during use notify District Testing and OMM.
725.15C	Unfused Pull-Apart Connection	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, markings and conformance to plan requirements. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.15D	Fused Bolted Connection	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, markings and conformance to plan requirements. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.15E	Unfused Permanent Connection	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, markings and conformance to plan requirements. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.16	Ground Rods	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, markings and conformance to plan requirements. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use contact OMM.
725.19H	Power Service Components Wood Pole	Products will be supplied by a source on the Certified List for S 1072 maintained by OMM. Received with TE-24 and supplier bill of lading. Check dimension, quantity and condition. Document in SM.	Notify District Testing and OMM, structural welding and metals section if rejecting material because material non-performs or looks defective during use.
725.21A	Luminaire Supports Light Poles	Verify pole provided by Certified Manufacturer under Supplement 1091. Inspect material for condition and conformance to plan requirements. Accept with TE-24 Document in SM	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.21B	Luminaire Supports Light Towers	Inspect material for condition and conformance to plan requirements. Verify pole provided by Certified Manufacturer under Supplement 1091. Accept with TE-24. Document in SM	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
725.21B9	Luminaire Support Anchor Bolts	OPTION 1 Verify type and brand name of material is on QPL at the time of use. Inspect for condition, and conformance to plan requirements. OPTION 2 Verify pole provided by Certified Manufacturer under S 1091. Accept with TE-24. Document in SM	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
726.01	Barrier Reflectors	Verify type and brand name of material is on QPL at the time of use. Inspect for condition and defect. Verify dimension conform to plan requirements. Document in SM.	Notify District Testing and OMM Chemical section if rejecting material because material non-performs or looks defective during use.
730.01	Steel Tube and Pipe	This item typically is a component of a sign support. Inspect total component for condition and conformance to shop drawings. Document in SM.	Notify District Testing if rejecting material.
730.015	U-Channel Posts	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District testing and OMM.

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
730.016	Square Posts	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.017	Wooden Box Beams	Contact OMM Structural Steel section for acceptance process. Document in SM.	Notify District Testing and OMM Structural Steel section if rejecting material.
730.02	Steel Anchor Bolts and Nuts	OPTION 1 Verify type and brand name of material is on QPL at the time of use. Inspect for condition, and conformance to plan requirements. OPTION 2 Verify pole provided by Certified Manufacturer under S 1093. Accept with TE-24. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.03	Steel Poles and Arms	Component material provided by Certified Manufacturer under Supplement 1093. Verify manufacturer is on 1093. Accept with TE-24. Document in SM	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.04	Base and Arm Plates	Component material provided by Certified Manufacturer under Supplement 1093. Verify manufacturer is on 1093. Accept with TE-24. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.05	Handhole Covers	Component material provided by Certified Manufacturer under Supplement 1093. Verify manufacturer is on 1093. Accept with TE-24. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.06	Pole Caps	Component material provided by Certified Manufacturer under Supplement 1093. Verify manufacturer is on 1093. Accept with TE-24. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.07	Arm Caps	Component material provided by Certified Manufacturer under Supplement 1093. Verify manufacturer is on 1093. Accept with TE-24. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.08	Steel Hardware	Component material provided by Certified Manufacturer under Supplement 1092 or 1093. Verify manufacturer is on 1092 or 1093. Accept with TE-24. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.09	Stainless Steel	Component material provided by Certified Manufacturer under Supplement 1092 or 1093. Verify manufacturer is on 1092 or 1093. Accept with TE-24. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.10	Stainless Steel Hardware	Component material provided by Certified Manufacturer under Supplement 1092 or 1093. Verify manufacturer is on 1092 or 1093 Accept with TE-24. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.11	Aluminum Sheet and Plate	Component material provided by Certified Manufacturer under Supplement 1092 or 1093. Verify manufacturer is on 1092 or 1093. Accept with TE-24. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.12	Aluminum Extrusions	Component material provided by Certified Manufacturer under Supplement 1092 or 1093.	Notify District Testing if rejecting material.

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
		Verify manufacturer is on 1092 or 1093. Accept with TE-24. Document in SM.	If material non-performs or looks defective during use notify District Testing and OMM.
730.13	Aluminum Tube and Pipe	Component material provided by Certified Manufacturer under Supplement 1092 or 1093. Verify manufacturer is on 1092 or 1093. Accept with TE-24. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.14	Aluminum Castings	Component material provided by Certified Manufacturer under Supplement 1092 or 1093. Verify manufacturer is on 1092 or 1093. Accept with TE-24. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.15	Aluminum Forgings	Component material provided by Certified Manufacturer under Supplement 1092 or 1093. Verify manufacturer is on 1092 or 1093. Accept with TE-24. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.16	Aluminum Welding Rods	Normally only applies to shop fabrication. If performing field aluminum welding contact District Testing and OMM for recommendations.	Notify District Testing if rejecting material.
730.17	Aluminum Hardware	Component material provided by Certified Manufacturer under Supplement 1092. Verify manufacturer is on 1092. Accept with TE-24. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.18	Reflective Sheeting Type F	Use if certification provided. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.19	Reflective Sheeting Type G	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.191	Reflective Sheeting Type G reboundable	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.192	Reflective Sheeting Type H	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.193	Reflective Sheeting Type J	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.20	Nonreflective Sheeting	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
730.22	Silk Screen Inks	No field acceptance requirements.- part of 730.19,191,192 or 193 items.	
730.23	Transparent Electronic Cuttable Films	No field acceptance requirements.- part of 730.19,191,192 or 193 items No field requirements.	
730.24	Digital Printing	No field acceptance requirements.- part of 730.19,191,192 or 193 items.	

700.00

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
731.03C	Changeable Message Sign, Electrical Type	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
731.05	Internally Illuminated Fixed Message Sign	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
731.06	Sign Flasher Assembly	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
731.07	School Speed Limit Sign Assembly	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
731.08	Flexible Conduit	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
731.10	Timer with Enclosure	Verify type and brand name of material is on TAP at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.01	Vehicular Signal Heads, Conventional	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.02	Vehicular Signal Heads, Optically Programmed, 12-inch (300 mm) Lens	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.03	Vehicular Signal Heads, Optically Programmed, 8-inch (200 mm) Lens	Provide Manufacturer's Certification verify material meets specification requirements Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.04 C	Vehicular and pedestrian light Emitting Diode Lamps (LED)	Verify type and brand name of material is on TAP at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.05	Pedestrian Signal Heads [Type A1] [Type A2] [Type D2]	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.06	Pedestrian Pushbuttons and Accessible Pedestrian Pushbutton	Verify type and brand name of material is on TAP at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.07 B	Loop Detector Units Nema TS 2	Verify type and brand name of material is on TAP at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
732.07C	Loop Detector Type 33x	Verify type and brand name of material is on TAP at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.11	Signal Supports	Check provided by Certified Manufacturer under Supplement 1094 Accept with TE-24. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.12	Strain Poles	Check provided by Certified Manufacturer under Supplement 1094 Accept with TE-24. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.13	Wood Poles	Check provided by Certified Manufacturer under Supplement 1072 Accept with TE-24. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.14	Down Guy Assemblies	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.15	Pedestals and Bases	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.16	Conduit Risers	See 725.04 requirements.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.17	Cable Support Assemblies	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.18	Messenger and Tether Wire	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.19	Cable and Wire	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.20	Power Service	See 725.04 requirements	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
732.21	Disconnect Switch with Enclosure	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
733.03 B	Cabinet Type TS 2	Verify type and brand name of material is on TAP at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
733.03 C	Cabinet Type 332	Verify type and brand name of material is on TAP at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
733.03 D	Cabinet Type 336L	Verify type and brand name of material is on TAP at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM
733.04 A	Cabinet Riser for TS 2 cabinet	Field inspect for 1/4 aluminum thickness and accept.	Notify District Testing if rejecting material.
733.04 B	Cabinet Riser for Types 332, 334 or 336	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
733.05	Flasher Controller	Verify type and brand name of material is on QPL at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
733.07	Remote Monitoring Station	Compatible with the supplied Supplemental Specification 809.10.G unit	Notify District Testing if rejecting material.
733.09	Uninterruptible Power Supply (UPS)	Verify type and brand name of material is on TAP at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
733.09.C	Battery System	Verify type and brand name of material is on TAP at the time of use. Inspect for conformance to dimension and condition. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
740.02	Traffic Paint	Verify material is on Approved List maintained by OMM. Accepted with TE-24. Inspect container for appropriate markings. Inspect material for uniform consistency. Document in SM.	If rejecting for performance provide 1 qt (1 L) sample and notify District Testing.
740.03	Polyester Pavement Marking	Verify material is on Approved List maintained by OMM. Accepted with TE-24. Inspect container for appropriate markings. Inspect material for uniform consistency. Document in SM.	If rejecting for performance provide 1 qt (1 L) sample and notify District Testing.
740.04	Thermoplastic Pavement Marking	Verify material is on Approved List maintained by OMM. Accepted with TE-24. Inspect container for appropriate markings. Inspect material for uniform consistency. Document in SM.	If rejecting for performance provide 1 qt (1 L) sample and notify District Testing.
740.05	Preformed Pavement Marking	Verify material is on Approved List maintained by OMM. Accepted with TE-24. Inspect container for appropriate markings. Inspect material for uniform consistency. Document in SM.	If rejecting for performance provide 1 qt (1 L) sample and notify District Testing.
740.06	Work Zone Pavement Marking [Type 1 Removable] [Type 2 Non-Removable]	Materials accepted by Engineer. Inspect material for uniform consistency. Document in SM.	If rejecting for performance provide 1 qt (1 L) sample and notify District.

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
740.07	Epoxy Pavement Marking Material	Verify material is on Approved List maintained by OMM. Accepted with TE-24. Inspect container for appropriate markings. Inspect material for uniform consistency. Document in SM.	If rejecting for performance provide 1 qt (1 L) sample and notify District Testing.
740.08	Heat-Fused Preformed Plastic Pavement Marking Material	Verify material is on Approved List maintained by OMM. Accepted with TE-24. Inspect container for appropriate markings. Inspect material for uniform consistency. Document in SM.	If rejecting for performance provide 1 qt (1 L) sample and notify District Testing.
740.09 A	Glass Beads – for 740.02	Verify material is on Approved List maintained by OMM. Accepted with TE-24. Inspect container for appropriate markings. Inspect material for uniform consistency. Document in SM..	If rejecting for performance provide 1 qt (1 L) sample and notify District Testing
740.09 B	Glass Beads – for 740.03	Verify material is on Approved List maintained by OMM. Accepted with TE-24. Inspect container for appropriate markings. Inspect material for uniform consistency. Document in SM.	If rejecting for performance provide 1 qt (1 L) sample and notify District Testing
740.09 C	Glass Beads – for 740.04	Verify material is on Approved List maintained by OMM. Accepted with TE-24. Inspect container for appropriate markings. Inspect material for uniform consistency. Document in SM.	If rejecting for performance provide 1 qt (1 L) sample and notify District Testing
740.09 D	Glass Beads – for 740.07	Verify material is on Approved List maintained by OMM. Accepted with TE-24. Inspect container for appropriate markings. Inspect material for uniform consistency. Document in SM.	If rejecting for performance provide 1 qt (1 L) sample and notify District Testing
748.01	Ductile Iron Pipe, Joints, and Fittings	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, suitability for intended use. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
748.02	Polyvinyl Chloride (PVC) Pipe, Joints, and Fittings	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, suitability for intended use. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
748.03	Polyethylene (PE) Service Branches and Fittings	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, suitability for intended use. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
748.05	Copper Service Branches and Fittings	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, suitability for intended use. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
748.06	Steel Pipe Encasement	Basis of acceptance is manufacturers certification containing documentation of domestic origin from manufacturer.	Notify District Testing if rejecting material
748.07	Polyethylene Encasement	Verify manufacturer certification conforms to ANSI/AWWA C105/A21.5 Inspect condition, dimension, suitability for intended use.	Notify District Testing if rejecting material.
748.08	Gate Valve and Valve Box	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, suitability for intended use.	Notify District Testing if rejecting material.

Spec No.	Material	Material only Inspection or Sampling Requirements	Additional Instructions
		Document in SM.	If material non-performs or looks defective during use notify District Testing and OMM.
748.09	Inserting Valve and Valve Box	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, suitability for intended use. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
748.10	Cutting-in Sleeve, Valve, and Valve Box	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, suitability for intended use. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
748.11	Tapping Sleeve, Valve, and Valve Box	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, suitability for intended use. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
748.12	Tapping Saddle and Corporation Stop	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, suitability for intended use. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
748.13	Service Stop and Service Box	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, suitability for intended use. Document in SM.	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.
748.14	Meter, Setting, Stop, and Chamber	Inspect for condition, dimension, suitability for intended use. Acceptance based on manufacturer's statement of conformity.	
748.15	Fire Hydrant	Verify type and brand name of material is on QPL at the time of use. Inspect for condition, dimension, suitability for intended use. Document in SM	Notify District Testing if rejecting material. If material non-performs or looks defective during use notify District Testing and OMM.

701 CEMENTITIOUS MATERIALS

701.00 Acceptance. Provide cements meeting 701.01, 701.02, 701.04, 701.05, 701.07 and 701.09 and certified according to Supplement 1028; fly ash or natural pozzolan meeting 701.13 and certified according to Supplement 1026; slag cement meeting 701.11 and certified according to Supplement 1034; and micro silica meeting 701.10 and certified according to Supplement 1045, without prior sampling, testing and approval by the Department. Lists for certified cement, fly ash, natural pozzolan, slag cement and micro silica sources are maintained by the Laboratory.

701.01 Air-Entraining Portland Cement. Provide air-entraining portland cement according to ASTM C 150, Type IA. The Gillmore time of set and the air permeability (fineness) tests will govern.

701.02 Portland Cement. Provide portland cement according to ASTM C 150, Type II. The Gillmore time of set and the air permeability (fineness) tests will govern.

701.04 Portland Cement. Provide portland cement according to ASTM C 150, Type I. The Gillmore time of set and the air permeability (fineness) tests will govern.

701.05 High Early Strength Portland Cement. Provide high early strength portland cement according to ASTM C 150, Type III. The Gillmore time of set test shall govern.

701.07 Masonry Cement. Provide masonry cement according to ASTM C 91.

701.09 Slag Modified Portland Cement. Provide slag modified portland cement according to ASTM C 595, Type IS (< 25).

701.10 Micro-Silica. Provide micro-silica according to ASTM C 1240. Do not use micro-silica admixtures in dissolvable bags.

701.11 Slag Cement. Provide slag cement according to ASTM C 989, Grade 100 minimum.

701.13 Fly Ash or Natural Pozzolan for Use in Portland Cement Concrete. Provide fly ash or natural pozzolan according to ASTM C 618, Class C, F, or N, except ensure a maximum loss on ignition (LOI) of 3 percent for fly ash and 5 percent for natural pozzolan.

Fly ash from sources certified according to Supplement 1026 and with an LOI greater than 3 percent may be approved for use by the Department if the fly ash is treated with a chemical conforming to Supplement 1115.

701.15 Portland-limestone Cement, Type IL. Provide portland-limestone cement according to ASTM C 595, Type IL. The maximum allowable limestone content is fifteen percent by mass.

702 ASPHALT MATERIAL

Acceptance. Asphalt binders 702.01 and liquid asphalts 702.02, 702.03, 702.04, 702.07, 702.12, 702.13, and 702.16 may be acceptable for shipment to and immediate use in construction projects. Acceptance is according to Supplement 1032 . Material will meet specification requirements and no tolerances are given for material falling out of specification requirements. The remaining materials may be acceptable for shipment to and immediately used in construction projects based on meeting the requirements of Department TE-24, QPL, or certified test data based on what each material requires.

702.00 Application Temperatures. Apply asphalt materials, according to the temperature ranges specified in Table 702.00-1.

TABLE 702.00-1

Type and Grade of Material	Application Temperature Range °F (°C)	
	Spray	Mix
MC-30	50 to 120 (10 to 49)	---
MC-70	75 to 150 (24 to 66)	---
MC-250	100 to 225 (38 to 107)	100 to 225 (38 to 107)
MC-800	150 to 250 (66 to 121)	150 to 225 (66 to 107)
MC-3000	225 to 275 (107 to 135)	200 to 250 (93 to 121)
All Emulsions	50 to 160 (10 to 71)	50 to 140 (10 to 60)
Asphalt Primer for Waterproofing	50 to 80 (10 to 27)	---
Asphalt for Waterproofing	300 to 350 (149 to 177)	---
CBAE 350, CBAE 350 SP	100 to 150 (38 to 66)	100 to 150 (38 to 66)
CBAE 800, CBAE 800 SP	125 to 175 (52 to 79)	125 to 175 (52 to 79)
Primer 20	60 to 120 (16 to 49)	---
Primer 100	75 to 125 (24 to 52)	---
Asphalt Binders	350 (177) Max.	325 (163) Max.
Asphalt Binders Polymer modified with SB, SBR, SBS, or Elvaloy	375 (190) Max	350 (177) Max.

702.01 Asphalt Binders.

General. According to AASHTO M 320-17 Table 1 and Supplement 1105 except as follows.

Ensure PG 70-22M, PG 76-22M, PG 88-22M, and PG 64-28 meet the requirements of Table 702.01-1.

An independent laboratory will not be owned or operated, in whole or part, by the binder supplier, Contractor, or affiliates of either.

Materials and Manufacture. Replace the requirements of AASHTO M 320-17 Table 1 Section 5 “Materials and Manufacture” Section with the following:

5.1 Supply PG Binder from the refining of crude petroleum, or combination of asphalt binders from the refining of crude petroleum, or asphalt binders and suitable

liquid from the refining of crude petroleum, and possible organic modifiers for performance enhancement. Material from the crude refining stream is considered neat. Liquid from crude refining may be used for adjustments, but do not used liquid from crude refining for the purpose of substitution of crude refined asphalt binder in a PG Binder. In the event of a failure investigation where asphalt binders exhibit unusual properties a supplier may be requested by OMM to supply information about the makeup of a PG Binder. Failure to cooperate will mean removal from Supplement 1032 certification.

5.2 A modifier may be any approved material of suitable manufacture that is proven compatible with asphalt binder (does not separate appreciably in routine storage), and that is dissolved or reacted in asphalt binder to improve its performance. Do not use paraffin wax, organic wax, or like materials. Performance enhancement is defined as a decrease in the temperature susceptibility of the asphalt binder while maintaining or improving desirable properties in a neat asphalt binder such as coat ability, adhesiveness and cohesiveness. Unless otherwise noted limit modifiers to no more than 6.0 percent by PG Binder weight.

5.3 The use of previously used materials in a PG Binder must be approved by OMM. Since no standard test procedures exist for reprocessed materials (and original tests were not developed with the use of such materials in mind), appropriate test methods may be chosen by OMM for review. OMM approval does not relieve the binder supplier from full responsibility for content and use of any previously used material in a PG Binder nor guarantee suitable performance enhancement as defined above. The detected presence in a PG Binder sample of any unapproved previously used material will mean immediate removal from Supplement 1032 certification. Do not use recycled engine oil bottoms (REOB), vacuum tower asphalt extender (VTAE), or like materials as modifiers. Limit approved previously used materials to 5.0 percent by PG Binder weight maximum and provide a written certification to OMM stating the exact percent used, the source, and any brand or trade names. Approved previously used materials are only allowed to be used to produce PG 58-28 and PG 64-28 and suppliers must get recertified per Supplement 1032 for these PG grades.

5.4 Ensure the PG Binder is homogeneous, free from water and deleterious materials, and does not foam when heated to 350 ºF (175 ºC). Prove the asphalt binder (before modification or after modification if liquid modifier used) is fully compatible with a negative result by means of the Spot Test per AASHTO T 102 using standard naphtha solvent. If standard naphtha shows a positive result, a retest using reagent grade 35 percent Xylene/ 65 percent Heptane (volume) may be used.

5.5 Ensure the PG Binder is at least 99.0 percent soluble as determined by AASHTO T44 or ASTM D7553. Ensure any insoluble component is free of fibers or discrete particles more than 75 µm.

5.6 Ensure flash point is 500 ºF (260 ºC) minimum. Ensure mass change on RTFO of the final PG Binder grade is 0.75 percent maximum.

5.7 PAV aged all PG grades at 212 ºF (100 ºC).

5.8 Direct Tension testing is not required, unless otherwise required in this specification.

Requirements for PG Modified Binder. Furnish PG Modified Binder according to the requirements of Table 702.01-1 by modifying a non-oxidized, non-air blown, neat asphalt binder by using a styrene butadiene latex rubber compound (SBR

polymer), a styrene butadiene styrene polymer block copolymer (SB, SBS polymer), an ethylene/ nbutyl acrylate/ glycidyl methacrylate copolymer (Elvaloy) as specified or Ground Tire Rubber (GTR) according to Supplemental Specification 887. For SB, SBS products the polymer supplier will certify to the refiner and Contractor that the polymer used meets a minimum 68 percent by weight butadiene content. Perform SB, SBS, Elvaloy or GTR modification prior to shipment to the asphalt concrete mixing plant (pre-blend). Perform SBR modification at the asphalt concrete mixing plant (post-blend) or prior to shipment to the asphalt concrete mixing plant (pre-blend) where allowed by specification.

Polyphosphoric acid (PPA) is allowed in PG binders as follows. PPA is a polymer of orthophosphoric acid. When using PPA ensure all the applicable requirements of the required PG binder in Table 702.01-1 are met. Ensure PPA does not contain water. To retain Supplement 1032 certification, suppliers of PPA modified asphalt will provide a written certification to OMM that the amount of PPA used is less than 1.0% by weight of neat binder. Suppliers of PPA can have their Supplement 1032 certification removed for not following the above PPA requirements.

For each project, the PG Modified Binder supplier will give the Contractor a handling guide specifying temperature, circulation, shelf life, and other requirements for assuring the PG Modified Binder will perform as desired. Give this handling guide to the Monitoring Team and place a copy in the plant control room and plant laboratory.

If PG Modified Binder is retained at the asphalt concrete mixing plant for more than two weeks before use or beyond the supplier recommended shelf life, whichever is less, a top and bottom sample test (material property difference between samples taken from the top and bottom of the storage tank) will be performed by OMM on samples retrieved by the Contractor at the Laboratory's direction. Do not use material on hand until approved.

TABLE 702.01-1, MATERIAL REQUIREMENTS FOR PG MODIFIED BINDER

Test / Requirement	SBR Polymer		Pre Blended Binder				Note
Final PG Binder Grade	70-22M (a, b)	64-28 (b)	64-28 (a)	70-22M (a,k)	76-22M (a,k)	88-22M (a,l,m)	c
Actual Pass Temperatures	Report						i
RTFO Mass Change, percent max	0.75						d
Phase Angle, max	78		78		74		d
Elastic Recovery, min			65		75	90	e, d
Toughness, in. lb	125	105					f, d
Tenacity, in lb.	70	80					f, d
Elongation, in. min	20	20					f, d
Ductility, in. min	28	28					j, d
Separation, F max	10						g, d
Homogeneity			None Visible				h, d

a. Pre-blended Binder. Use a base neat asphalt binder that is a -22 grade for 70-22M and 76-22M. Use a base neat asphalt binder that is a -28 grade for 64-28. 64-28 can be neat, PPA modified or modified with SB, SBS or Elvaloy. 64-28 PPA only modified does not have to meet the

phase angle or elastic recovery requirements. Ensure SB, SBS or Elvaloy modified 64-28 meets all requirements listed.

b. Post-blended Binder made from neat Supplement 1032 certified or preapproved standard PG Binder grade and SBR solids amount equal to or above 3.5 percent by weight of total binder to achieve the PG Binder grade. Ensure all listed properties are met.
c. Without Direct Tension, graded with actual pass temperatures
d. PG Modified Binder
e. AASHTO T301, 10cm @ 77 ºF (25 ºC), hold 5 min. before cutting, on RTFO material for SB, SBS, and Elvaloy. Note elongation after one hour to the nearest 0.01 cm and report elastic recovery to nearest 0.1%.
f. ASTM D 5801, 50cm/min @ 77 ºF (25 ºC)
g. Condition samples according to ASTM D7173. Conduct softening point difference of top and bottom of tube per AASHTO T53. Compatibility of polymer and neat binder is sole responsibility of supplier. Formulate PG Modified Binder to retain dispersion for 3 days minimum.
h. Heat a minimum 400 gram sample at 350 ºF (177 ºC) for 2.5-3 hours. Pour entire sample over a hot No. 50 (300 µm) sieve at 340 ºF (171 ºC). Look for retained polymer lumps.
i. Actual high and low temperature achieved by PG Modified Binder beyond required grade, but will not grade out to the next standard PG Binder grade for low temperature.
j. AASHTO T51, @ 39 ºF (4 ºC), 1 cm/min
k. SB, SBS, Elvaloy or Supplemental Specification 887 GTR
l. SB, SBS, Elvaloy
m. The requirements of 3.0 Pa*s maximum for the rotational viscosity for 88-22M may be waived at the discretion of the Department if the supplier warrants that the asphalt binder can be adequately pumped, mixed, and compacted at or below the temperature requirements in Table 702.00-1. Do not exceed 10.0 Pa*s rotational viscosity using the #27 spindle at time of shipment.

702.02 Cut-Back Asphalt. Provide medium curing cut-back asphalt according to AASHTO M 82. Instead of viscosity on the residue, the penetration in note 2 (AASHTO M 82) will govern.

702.03 Cut-Back Asphalt Emulsions. Prepare emulsions by compounding a suitable volatile solvent and water with 702.01 asphalt to produce emulsions according to Table 702.03-1.

TABLE 702.03-1

	CBAE-350	CBAE-350 Special	CBAE-800	CBAE-800 Special	Primer 20	Primer 100
Kinematic Viscosity at 60 °C, Centistokes	350-700	350-700	800-1600	800-1600	20-40	100-200
Water Content[1], %	4-12	4-12	4-12	4-12	3-8	3-8
Volatile Solvent[1], %	12-25	12-25	10-20	10-20		
Asphalt Content[1], %	67+	67+	72+	72-	45+	60-
Adhesion Test[1]	[2]	[2]	[2]	[2]		
Wet Stone Coating Test[1]		[2]		[2]	[2]	[2]
Stripping Test[1]		[2]		[2]		
	Tests on Residue From Distillation					
Penetration at 25 °C	80-150	80-150	80-150	80-150	100-200	100-200
Ductility at 25 °C, in. cm	100+	100+	100+	100+	100+	100+
Total Binder (Sol. in CSx), %	99+	99+	99+	99+	99+	99+
[1] Perform tests according to Supplement 1014.						
[2] Meets						

702.04 Emulsified Asphalts. Provide emulsified asphalts according to AASHTO M 140 or AASHTO M 208 except specification limits will be producible for at least 30 days from sample date. Use Saybolt Furol for viscosity.

702.05 Asphalt Primer for Waterproofing. Provide asphalt primer for waterproofing according to ASTM D 41 Type 2.

Furnish materials according to the Department's QPL.

702.06 Asphalt for Waterproofing. Provide asphalt for waterproofing according to ASTM D 312, Type III.

Furnish materials according to the Department's QPL.

702.07 Asphalt Emulsion MWS. Prepare asphalt emulsion MWS from a base material according to 702.01, except vary the penetration to meet the float test and penetration specified below. Ensure that the emulsion coats the aggregate readily, thoroughly, and uniformly. Ensure that the specified characteristics do not change during transportation, normal storage and that the emulsion is according to the following when tested according to AASHTO T 59 within 30 days after sample date:

Saybolt furol viscosity at 77 °F (25 °C), seconds	50+ [1]
Asphalt residue, percent	68+
Settlement, 7 days, percent	5-
Sieve test	0.1-
Coating test	[2]
Oil distillate, percent	7-
Withstand freezing to	-10 ºF (-23 °C) [3]
Particle charge	Negative
Penetration, 77 °F (25 °C) [6]	[4]
Float test at 140 °F (60 °C), seconds [6]	1200+ [5]
% Solubilty [6]	97.5+
Ash content, percent [6]	2.0-

[1] Pumpable.

[2] Use aggregates to test the emulsion that are from sources standardized by OMM. Use aggregates consisting of 100 percent passing a 3/8 inch (9.5 mm) sieve and 0 percent passing a 1/4 inch (6.3 mm) sieve. Wash the standard reference aggregates with distilled water until free of dust, and dry them.

Weigh 3.280 ounces (93 grams) of the dry graded reference aggregate into a suitable container. Weigh 0.247 ounces (7 grams) of the emulsion onto the aggregate in the container, and vigorously mix the contents for 5 minutes. After mixing, thoroughly coat the stone. Completely immerse the mixture in tap water, and immediately pour off the tap water. Ensure that the aggregate surface area is at least 90 percent coated.

[3] When shipped after October 1 and before April 15, except if the emulsion is stored and mixed at temperatures of emulsion, aggregate, and atmosphere above 40 °F (5 °C).

[4] Select the penetration within the following ranges of the designation specified:

[5] AASHTO T 50, except immediately pour residue from distillation into the float collar at 500 °F (260 °C); or if the residue has been allowed to cool, heat it again to 500 °F (260 °C) and pour it into the float collar.

[6] Test on residue from distillation per AASHTO T44 or ASTM D7553

Designation	**Penetration at 77 °F (25 °C)**
MWS 300	300+
MWS 150	150 to 300
MWS 90	90 to 150
MWS 60	60 to 90

702.08 Cold Liquid-Applied Elastomeric Waterproofing Membrane. Provide Cold Liquid-Applied Elastomeric Waterproofing Membrane as follows:

Hardness Type 00, min.	50	ASTM D-2240 as modified in Section 6.5 of ASTM C-836
Low temperature crack bridging	no cracking	ASTM C-1305 as modified in Section 6.7 of ASTM C-836
Adhesion-in-peel after water imeersion	1[4.4]	ASTM C-794 as modified in Section 6.9 of ASTM C-836 min. Lbf [N] (no optional test allowed)
Extensibility after heat aging, min. in [mm]	¼ [6.4]	ASTM C-1522
Hydrostatic Resistance min. psi	25[0.16]	ASTM C-1306

Provide Certified Test Data to the Engineer for each shipment of material .

702.09 Hot Applied Asphaltic Joint Adhesive. Provide hot applied asphaltic joint adhesive meeting the following requirements:

TABLE 702.09-1

Test	Description	Requirement
ASTM D 3236	Brookfield Viscosity @ 400°F (205°C)	4,000 - 10,000 CP
ASTM D 5329	Cone Penetration @ 77°F (25°C)	60-100 dmm
ASTM D 5329	Flow @ 140°F (60°C)	5 mm Max.
ASTM D 5329	Resilience @ 77°F (25°C)	30 % Min.
ASTM D 113	Ductility @ 77°F (25°C)	30 cm Min.
ASTM D 113	Ductility @ 39.2°F (4°C)	30 cm Min.
ASTM D 5329	Tensile Adhesion @ 77°F (25°C)	500 % Min.
AASHTO T 53	Softening Point	170°F Min.
ASTM D 5329	Asphalt Compatibility	Pass

Furnish hot applied asphaltic joint adhesive according to the Department's TE-24.

702.12 Non-Tracking Asphalt Emulsion. Provide certified non-tracking asphalt emulsion material meeting Table 702.12-1 and Supplement 1128 and Supplement 1032. Emulsion will comply with all specification requirements for at least 30 days after sample date.

TABLE 702.12-1

Tests on emulsion, AASHTO T 59, unless otherwise designated:	
Viscosity, Saybolt Furol at 77 °F (25 °C) (SFS)	20 to 100
Storage Stability Tests, 24-hr (% difference), max.	1.0
Settlement tests, 5-day (% difference), max.	5.0
Sieve Tests (%) (Distilled Water), max.	0.30
Distillation, Residue % solids, min. [1]	50
Oil distillate, %, max.	3

[1] Products may use residual by evaporation to perform residual and may use the material to perform residual tests but must be submitted during approval process in S-1128. Will be required to perform residual by distillation to obtain oil distillate %.

702.13 SBR Asphalt Emulsion. Provide material consisting of asphalt emulsion SS-1, SS-1h, CSS-1 or CSS-1h per 702.04 and Supplement 1032, blended with SBR emulsion per 702.14, to produce a residual mixture of asphalt binder and SBR solids having a composition of 97.0 ± 0.3 percent asphalt binder and 3.0 ± 0.3 percent SBR solids by weight.

Furnish a certification to the Engineer and signed by the contractor containing the following:

A. The weight of SBR emulsion blended with the asphalt emulsion.

B. The weight of asphalt emulsion blended with the SBR emulsion.

C. The SBR emulsion manufacturer certification per 702.14.

D. The percent of asphalt binder in the asphalt emulsion (residue by distillation).

E. The percent of SBR solids in the SBR emulsion.

F. The percent of SBR solids in the mixture of asphalt binder residue and SBR solids.

G. Name of Certified asphalt emulsion producer and asphalt emulsion.

Determine the weight of the SBR emulsion to be added to a designated weight of asphalt emulsion to provide the percent of SBR solids in the mixture of asphalt residue and SBR solids using the following formula:

$$X = \frac{0.0309(B)(W)}{(A)}$$

where:

X = pounds (kilograms) of SBR emulsion
A = percent SBR solids in the SBR emulsion
B = percent of asphalt residue of the asphalt emulsion
W = pounds (kilograms) of the asphalt emulsion

For field blending, ensure the asphalt emulsion and SBR emulsion are thoroughly mixed as follows before application: Add to the distributor the asphalt emulsion and the required amount of the SBR emulsion of the appropriate SBR emulsion type (i.e.

cationic or anionic). Heat and circulate the distributor contents for at least 30 minutes to ensure complete blending. Re-circulate the distributor contents for 10 minutes just prior to application. If the distributor has set for 12 hours without circulation, repeat the heating and circulating of the distributor contents for 30 minutes prior to application.

Draw samples of the mixed SBR and asphalt emulsion after mixing the materials as indicated above. Emulsion will comply with all specification requirements for at least 30 days after sample date.

702.14 SBR Emulsion. Ensure the SBR emulsion is a cold polymerized Styrene Butadiene synthetic rubber (SBR) in latex form specifically compounded for use in asphalt binders and asphalt emulsions. Ensure the manufacturer of the SBR emulsion furnishes a written certification of the total SBR solids content of the SBR emulsion and actual test results showing compliance with both of the following requirements:

A. SBR emulsion:

Type of SBR Emulsion:	**Anionic**	**Cationic**
SBR solids Styrene Butadiene Ratio	27 ±5 : 73 ±5	27 ±5 : 73 ±5
Total SBR solids, % by weight	60-72	60-72
SBR solids Residual Styrene, % by weight	0.1 max	3.5 0.1 max
Ash, % of total SBR solids by weight	3.5 max	3.5 max
pH	9-11	4-6
Viscosity, Brookfield Units, Model RVF, spindle No 2 @20 RPM@ 77° F (25 ºC)	2000 max	2000 max

B. Combination of 3.0 – 4.0 % SBR solids with 96.0 – 97.0 % PG 64-22 meeting 702.01 by weight:

Toughness inch-pounds (N×m), Minimum 133 (15)
Tenacity, inch-pounds (N×m), Minimum 80 (9)

702.16 Polymer Emulsified Binder. Material will meet specification requirements of the table below.

TABLE 702.16 POLYMER EMULSIFIED BINDER

Tests on Emulsion (AASHTO T 59):	**Type A** (b)	**Type B** (c,g)	**Type C** (h)
Saybolt Furol Viscosity (g)	120-550 (50 ºC)	20-100 (25 ºC)	20-100 (25 ºC)
Storage stability, 24 hrs., % difference, max (a)	1	1	1
Demulsibility, 35 ml of 0.8% Dioctyl Sodium Sulf., min	50	60	
Demulsibility, 35 ml of 0.02N, CaCl2, %, min		60	
Particle Charge Test	Positive		Positive
Sieve test, (distilled water), %, max	0.1	0.05	0.10
Distillation to 177 ºC, residue % solids (d)	66	63	62
Oil distillate, %, max	2	2	
Tests on Distillation Residue:			
Penetration, 100g, 5 sec @ 77 ºF (25ºC) AASHTO T 49	70-125	90-150	40-90
Softening point, º C, min AASHTO T 53	57		60
Solubility, %, min AASHTO T44 or ASTM D7553 (i)	97.5	97.5	97.5
Elastic Recovery, 50 ºF (10º C), %, min AASHTO T 301, (e),(f)	60	58	50
Ductility, 25 °C, 5 cm/min, (cm), min. AASHTO T 51			40

(a) After standing undisturbed for 24 hours, the surface will show no white, milky colored substance, but will be a smooth homogeneous color throughout.
(b) CRS-2P, test within 20 days of project sampling. Limits for both certified source and project samples.
(c) CRS-1P and HFRS-1P, test within 20 days of project sampling. Limits for both certified source and project samples.
(d) See Supplement 1013. For Type C if natural latex is used, use the Oven Evaporation method in AASHTO T 59 in place of distillation and use this residue for further testing.
(e) Straight molds. Hold at test temperature for 90 minutes. Place in ductilometer and elongate 20 cm at 5 cm/min. Hold for 5 minutes and cut. After 1 hour retract the broken ends to touch and note elongation in cm (X) to the nearest 0.01cm. Percent Recovery = ((20-X)/20) x 100. Report elastic recovery to nearest 0.1%.
(f) SBR, SBS, & SB
(g) Minimum of 70 SFS for project acceptance
(h) CSS-1hM, test within 30 days of sampling. Limits for both certified source and project samples. Do not use port addition of the polymer to the emulsified asphalt. Include the percent residue on the Bill of Lading.
(i) On base asphalt only

702.17 Crack Sealant

A. Type I Crack Sealant. Conform to 705.04

B. Type II Crack Sealant. Provide a mixture of PG 64-22 certified binder (Supplement 1032) and polyester fibers (recycled fibers not permitted) according to the following requirements:

Denier; ASTM D 1577* ..... 3.0 to 6.0
Length ..... 0.25 ± 0.02 inch (6.35 ± 0.51mm)
Crimps; ASTM D 3937 ..... None

Tensile str, min. ASTM D2256*..... 70,000 psi (483 Mpa)
Specific gravity.....1.32 to 1.40
Minimum melting temperature ..... 475 ºF (256 ºC)
Ignition temperature..... 1000 ºF (538 ºC) min.

*This data must be obtained prior to cutting the fibers.

The fiber and fiber manufacturer must be on the Department's QPL.

Combine materials so the fibers are a minimum of 5.0 percent by total weight of the asphalt binder. Ensure combined materials are according to the following properties:

Strength (at break)
at 72 ºF (22 ºC) .....350 psi (2.4 MPa) min.
at 0 ºF (-18 ºC) .....500 psi (3.5 MPa) min.
Elongation (at break)
at 72 ºF (22 ºC) .....50 percent min.
at 0 ºF (-18 ºC) ..... 20 percent min.

The option for using premixed and prepackaged Type II crack sealant is permitted provided (1) the fibers and the fiber binder are according to the requirements as shown and, (2) the fiber binder is according to the manufacturer's specifications, and (3) must be on Department's QPL. Furnish certified test data from the fiber binder manufacturer annually to OMM, and when requested by OMM. Furnish a letter of certification with each shipment stating that the material complies with specification requirements.

C. Type III Crack Sealant. Provide a mixture of PG 64-22 certified binder (Supplement 1032) and polypropylene fibers (recycled fibers not permitted) according to the following requirements:

Denier; ASTM D 1577*..... 15 ±3
Length,.....0.39 ± 0.08 inch (9.91 ± 2.0 mm)
Crimps; ASTM D 3937..... None
Tensile strength, min, ASTM D 2256*.....40,000 psi
..... (276 MPa)
Specific gravity..... 0.91 ± 0.04
Minimum melting point..... 320 ºF (160 ºC)

* This data must be obtained prior to cutting the fibers.

The fiber and fiber manufacturer must be on the Department's QPL.

Combine materials so the fibers are a minimum of 7.0 percent by total weight of the asphalt binder. Ensure combined materials are according to the following properties:

Strength (at break)
at 72 ºF (22 ºC) .....350 psi (2.4 MPa) min.
at 0 ºF (-18 ºC) .....500 psi (3.5 MPa) min.
Elongation (at break)
at 72 ºF (22 ºC) ..... 50 percent min.
at 0 ºF (-18 ºC) ..... 20 percent min.

D. Type IV Crack Sealant. Provide a prepackaged, preapproved mixture of modified binder according to the following properties and minimum 2.0 percent polyester fibers (recycled fibers not permitted) according to the following properties.

Modified binder:

Cone penetration, 77 ºF (25 ºC)	50-90
Flow, 140 ºF (60 ºC)	1.0 cm max
Resilience, 77 ºF (25 ºC)	25-60 percent
Ductility, 77 ºF (25 ºC)	40 cm min
Bond, 0 ºF (-18 ºC), 100 percent ext. Pass	5 cycles
Impact, 0 ºF (-18 ºC)	Pass
Compression recovery	0.40 min
Recommended pour temperature	380 ºF (193 ºC)
Safe heating temperature	410 ºF (210 ºC)

Fiber must meet requirements for Type II polyester fiber. Fiber and fiber manufacturer must be on the Department's QPL.

Safe heating temperature	400 ºF (204 ºC)
Softening point	190 ºF (88 ºC)
Viscosity, 400 ºF (225 ^{0}C)	3000 cp min
Cone penetration, 77 ºF (25 ºC)	25-45

Workability - Capable of being melted and applied through a pressure feed, indirect heated and agitated melter

Flexibility*	Pass

* 1 inch (25mm) sample at -20 ºF (-30 ºC), 90 degree bend, 10 sec

Crack sealant and crack sealant manufacturer must be on the Department's QPL.

E. Type V Crack Sealant. Provide a prepackaged, preapproved hot-applied asphalt mastic sealant meeting ASTM D8260-20, Type 2. Provide certified test data to the Engineer

Furnish materials according to the Department's QPL.

703 AGGREGATE

703.01 General.

The following abbreviations apply:

CCS	Crushed Carbonate Stone.
ACBFS	Air Cooled Blast Furnace Slag
GS	Granulated Slag
RAP	Reclaimed Asphalt Pavement
RPCC	Recycled Portland Cement Concrete
OH	Open Hearth Slag
EAF	Electric Arc Furnace Slag
BOF	Basic Oxygen Furnace Slag
PCS	Petroleum Contaminated Soil

Prequalified Aggregate Supplier Program (Supplement 1069). Provide aggregate materials to the Ohio Department of Transportation from prequalified suppliers.

A. Soundness. When the major portion of the unsound material in a coarse aggregate acquires a mud-like condition when tested for soundness, ensure that the maximum loss for all uses is 5 percent.

B. Stockpiles. Use stockpiling and loading methods that permit ready identification of the aggregates and to minimize segregation. Clean the sites for stockpiles before storing materials. Do not remove aggregates from stockpiles within 1 foot (0.3 m) of the ground until final cleanup of the work. Do not use material that has become mixed with foreign matter, wood or other size or grades of aggregates.

Handle aggregates in such a manner that the moisture content is reasonably uniform for each day's run.

C. Size. Provide aggregate according to the size specified in the material specification, the construction item, or as shown in AASHTO M 43.

D. Method of Test. Provide aggregate tested by the following methods:

Amount finer than No. 200 (75 µm) sieve S1004
Clay lumps S1017
Coal and lignite..... AASHTO T 113
Crushed pieces..... ASTM D 5821
Deleterious materials..... S1029
Effect of organic impurities on
strength of mortar ..... AASHTO T 71
Liquid limit..... AASHTO T 89
Percent of wear, Los Angeles
abrasion test ..... AASHTO T 96 or ASTM C 535
Plasticity index ..... AASHTO T 90
Sieve analysis S1004, S1005
Sieve analysis of mineral filler..... AASHTO T 37
Sodium sulfate soundness test,
5 cycle ..... AASHTO T 104
Specific Gravity and percent absorption
for fine and coarse aggregate..... S1031
Unit weight..... AASHTO T 19
Lightweight chert in aggregates ..... AASHTO T 113
Sand equivalent ..... AASHTO T 176
Uncompacted void content ..... AASHTO T 304
Flat and elongated..... ASTM D 4791
Rapid freezing and thawing .... ASTM C 666, Procedure B
Insoluble residue of carbonate
aggregates ..... ASTM D 3042
Compaction testing of Unbound Materials S1015
In place gradation sampling..... S1090
Sulfur leachate test..... S1027
Soundness of aggregate by freezing
and thawing..... AASHTO T 103
Micro-Deval ..... AASHTO T 327

Silicon Dioxide..... ASTM C 146, ASTM C 114
Sodium sulfate soundness test,
Rock slabs..... ASTM D 5240

E. Steel Slag Aggregate. Provide open-hearth (OH), basic oxygen furnace (BOF), and electric arc furnace (EAF) steel slag aggregate (known as steel slag) according to the following requirements when 703.04 aggregate for asphalt concrete base or 703.05 aggregate for asphalt intermediate course is specified. Do not use OH, BOF, or EAF slag as the fine or coarse aggregate (virgin or recycled) for asphalt surface courses.

Supply all steel slag from sources according to Supplement 1071. Furnish steel slag to a size meeting the specified grading requirements. Provide steel slag aggregate meeting the specified coarse or fine aggregate quality requirements. Ensure that measurements of soft pieces include soft lime, lime oxide, or magnesia agglomerations or any foreign materials prone to rapid disintegration under construction processing and weathering conditions. Ensure that additional testing beyond those listed are performed or required any time poor quality steel slag is suspected due to visual inspection, testing, or field performance problems.

Provide a letter of certification to the Engineer from the steel slag processor for every shipment of steel slag to the Contractor. In addition the steel slag processor must provide the Engineer with the following:

Quality control records (created in accordance with Supplement 1071).

Documentation of the steel slag production, processing, and stockpile retrieval

Failure to follow the processor QC plan or continued problems with performance recognized by the Laboratory attributable to steel slag is cause for limiting steel slag use from that processor.

F. Restrictions. When an aggregate source is specially designated with a "SR or SRH" according to *Guidelines for Maintaining Adequate Pavement Friction in Surface Pavements,* the aggregate source will be restricted for use in surface pavement according to the methods in the guidelines. The document, *Guidelines for Maintaining Adequate Pavement Friction in Surface Pavements*, is available on the OMM website under "Material Information by Category, Aggregate", or the Office of Pavement Engineering's website.

TABLE 703.01-1 SIZE OF COARSE AGGREGATE (AASHTO M 43)

Size No.	Nominal size [1] square openings inch	mm	Amounts finer than each laboratory sieve (square openings), percent by weight 4 in. 100 mm	3 1/2 in. 90 mm	3 in. 75 mm	2 1/2 in. 63 mm	2 in. 50 mm	1 1/2 in. 37.5 mm	1 in. 25 mm	3/4 in. 19 mm	1/2 in. 12.5 mm	3/8 in. 9.5 mm	No. 4 4.75 mm	No. 8 2.36 mm	No. 16 1.18 mm	No. 50 300 µm	No. 100 150 µm
1	3 1/2 to 1 1/2	90 to 37.5	100	90 to 100		25 to 60		0 to 15		0 to 5							
2	2 1/2 to 1 1/2	63 to 37.5			100	90 to 100	35 to 70	0 to 15		0 to 5							
24	3 1/2 to 3/4	63 to 19			100	90 to 100		25 to 60		0 to 10	0 to 5						
3	2 to 1	50 to 25				100	90 to 100	35 to 70	0 to 15		0 to 5						
357	2 to No. 4	50 to 4.75				100	95 to 100		35 to 70		10 to 30		0 to 5				
4	1 1/2 to 3/4	37.5 to 19					100	90 to 100	20 to 55	0 to 15		0 to 5					
467	1 1/2 to No. 4	37.5 to 4.75					100	95 to 100		35 to 70		10 to 30	0 to 5				
5	1 to 1/2	25 to 12.5						100	90 to 100	20 to 55	0 to 10	0 to 5					
56	1 to 3/8	25 to 9.5						100	90 to 100	40 to 75	15 to 35	0 to 15	0 to 5				
57	1 to No. 4	25 to 4.75						100	95 to 100		25 to 60		0 to 10	0 to 5			
6	3/4 to 3/8	19 to 9.5							100	90 to 100	20 to 55	0 to 15	0 to 5				
67	3/4 to No. 4	19 to 4.75							100	90 to 100		20 to 55	0 to 10	0 to 5			
68	3/4 to No. 8	19 to 2.36							100	90 to 100		30 to 65	5 to 25	0 to 10	0 to 5		
7	1/2 to No. 4	12.5 to 4.75								100	90 to 100	40 to 70	0 to 15	0 to 5			
78	1/2 to No. 8	12.5 to 2.36								100	90 to 100	40 to 75	5 to 25	0 to 10	0 to 5		
8	3/8 to No. 8	9.5 to 2.36									100	85 to 100	10 to 30	0 to 10	0 to 5		
89	3/8 to No. 16	9.5 to 1.18									100	90 to 100	20 to 55	5 to 30	0 to 10	0 to 5	
9	No. 4 to 16	4.75 to 1.18										100	85 to 100	10 to 40	0 to 10	0 to 5	
10	No. 4 to 0 [2]	4.75 to 0 [2]										100	85 to 100				10 to 30

[1] Numbered sieves are those of the United States Standard Sieve Series.

[2] Screenings.

Where standard size of coarse aggregate designated by two or three digit numbers are specified, obtain the specified gradation by combining the appropriate single digit standard size aggregates by a suitable proportioning device which has a separate compartment for each coarse aggregate combined. Perform the blending as directed by the Laboratory.

703.02 Aggregate for Portland Cement Concrete.

A. Fine Aggregate.

1. Provide fine aggregate consisting of natural sand or sand manufactured from stone.

2. Sieve analysis.

Sieve Size	Total Percent Passing
3/8 inch (9.5 mm)	100
No. 4 (4.75 mm)	95 to 100
No. 8 (2.36 mm)	70 to 100
No. 16 (1.18 mm)	38 to 80
No. 30 (600 µm)	18 to 60
No. 50 (300 µm)	5 to 30
No. 100 (150 µm)	0 to 10
No. 200 (75 µm)	0 to 5

Should the fineness modulus of a job control sample of sand from any source vary by more than 0.20 percent from that of the representative sample from that source, the sand may be rejected.

3. Physical properties.

	Maximum
Loss, sodium sulfate soundness test	10%
Aggregations of soil, silt, etc. by weight	0.5 %

When tested for the effect of organic impurities on strength of mortar, ensure that the compressive strength at 3 and 7 days of mortar made with untreated sand is not less than 95 percent of the compressive strength of mortar made with treated sand.

Provide fine aggregate for Items 255, 256, 451, 452, 526, and 511 deck slabs with at least 25 percent siliceous particles as determined by the acid insoluble residue test [ASTM D3042]. Ensure material has been tested and results are on file at the Laboratory. For sources not tested and on file at the laboratory, submit certified test data from an AMRL accredited independent laboratory verifying the minimum 25 percent.

B. Coarse Aggregate.

1. Provide coarse aggregate consisting of washed gravel, CCS, or crushed ACBFS.

2. Physical properties.

Percent of wear, Los Angeles test, maximum (CCS or washed gravel)	40 %
Unit weight, compacted, minimum (slag)	70 lb/ft^3 (1120 kg/m^3)
Loss, sodium sulfate soundness test, maximum:	12%

Deleterious substances shall not exceed the following:

	Percent by Weight	
Material Type	**Super-Structure**	**All Other Concrete**
Soft pieces	2.0	3.0
Coal and lignite	0.25	1.0
Clay lumps	0.25	0.25
Pieces having a length greater than 5 times the average thickness	15	15
Shale and shaly material	0.5	1.0
Limonitic concretions	0.5	1.0
Alkali	0.5	1.0
Metallic particles	0.5	1.0
Chert, that disintegrates in 5 cycles of the soundness test	0.5	1.0

Additional requirement for ACBFS aggregate:

Total Sulfur as S, maximum (ASTM C114)	2.0%

3. Amount passing the No. 200 (75 μm) sieve. Ensure that the percent by weight of material passing the No. 200 (75 μm) sieve in the aggregate portion of the concrete mix does not exceed the following:

	Percent by Weight	
Material Type	**Super-Structure**	**All Other Concrete**
CCS and crushed ACBFS	3.4	3.8
Washed gravel	2.0	2.2

703.03 Fine Aggregate for Mortar or Grout.

A. Provide fine aggregate consisting of natural sand or sand manufactured from stone or ACBFS.

B. Sieve Analysis.

	Natural Sand	Manufactured Sand
Sieve Size	**Total Percent Passing**	
No. 4 (4.75 mm)	100	100
No. 8 (2.36 mm)	95 to 100	95 to 100
No. 50 (300 μm)	10 to 40	20 to 40
No. 100 (150 μm)	0 to 15	10 to 25
No. 200 (75 μm)	0 to 5	0 to 10

C. Physical properties.

	Maximum
Loss, sodium sulfate soundness test	10 %
Aggregations of soil, silt, etc. by weight	0.5 %

When tested for the effect of organic impurities on strength of mortar, ensure that the compressive strength of mortar made with untreated sand is not less than 95 percent of the compressive strength of mortar made with treated sand.

703.04 Aggregate for Asphalt Concrete Base (301 and 302).

A. Provide coarse aggregate for asphalt concrete base used in combination with rigid pavement consisting of CCS, gravel, or crushed ACBFS.

Provide coarse aggregate for asphalt concrete base used in flexible pavements consisting of CCS, gravel (see note [1] in table below), or crushed ACBFS. Provide fine aggregate for asphalt concrete base consisting of natural sand or sand manufactured from stone, gravel, or ACBFS. Crushed Steel Slag (OH, EAF or BOF) conforming to 703.01.E and 440.02 may be used for coarse and fine aggregate in asphalt concrete base used in flexible pavements.

B. Physical properties.

Percent of wear, Los Angeles test, maximum (CCS or washed gravel)	50 %
Unit weight, compacted, minimum (slag)	65 lb/ft^3 (1040 kg/m^3)
Loss, sodium sulfate soundness test, maximum	15 %
Percent by weight of fractured pieces (one or more faces), minimum	40 %
Micro-Deval Abrasion Loss test, maximum (for coarse aggregate gravel only)	22 % [1]
[1] If the MD value is greater than the specification limit conform to Supplement 1010.	

Deleterious substances shall not exceed the following:

Material Type	Percent by Weight
Soft pieces	3.0
Coal and lignite	1.0
Clay lumps	0.25
Pieces having a length greater than 5 times the average thickness	15
Shale and shaly material	2.5
Chert that disintegrates in 5 cycles of the soundness test	2.5

703.05 Aggregate for Asphalt Concrete (Intermediate and Surface Courses), Prime Coat (408), Chip Seal (422), and Microsurfacing (421).

A. Fine Aggregate.

1. Provide fine aggregate consisting of natural sand or sand manufactured from stone, gravel, ACBFS or, for intermediate courses only, steel slag (OH, EAF or BOF) conforming to 703.01.E and 440.02.

2. Sieve analysis.

Standard 703.05 Gradation

Sieve Size	Total Percent Passing
3/8 inch (9.5 mm)	100
No. 4 (4.75 mm)	90 to 100
No. 8 (2.36 mm)	65 to 100
No. 16 (1.18 mm)	40 to 85
No. 30 (600 µm)	20 to 60
No. 50 (300 µm)	7 to 40
No. 100 (150 µm)	0 to 20
No. 200 (75 µm)	0 to 10

Screenings

Sieve Size	Total Percent Passing
3/8 inch (9.5 mm)	100
No. 4 (4.75 mm)	85 to 100
No. 100 (150 µm)	10 to 30

3. Physical properties.

	Maximum
Loss, sodium sulfate soundness test	15 %
Aggregations of soil, silt, etc., by weight	0.5 %

B. Coarse Aggregate.

1. Provide coarse aggregate consisting of CCS, crushed ACBFS, washed gravel, or for intermediate courses only, steel slag (OH, EAF or BOF) conforming to 703.01.E and 440.02.

2. Physical properties.

Percent of wear, Los Angeles test, maximum (CCS or washed gravel)	40 %
Unit weight, compacted, minimum (slag):	
Asphalt Concrete, 408 and 422	70 lb/ft^3 (1120 kg/m^3)
Loss, sodium sulfate soundness test, maximum:	
Asphalt Concrete and 422	12 %
421	15 %
Percent by weight of fractured pieces (one or more faces), minimum	40 %
Micro-Deval Abrasion Loss test, maximum (for gravel only)	20 % [1]
[1] If the MD value is greater than the specification limit conform to Supplement 1010.	

Deleterious substances shall not exceed the following:

Material Type	Percent by Weight
Soft pieces	3.0
Coal and lignite	1.0
Clay lumps	0.25
Amount finer than No. 200 (75 µm) sieve	3.0
Pieces having a length greater than 5 times the average thickness	15
Shale and shaly material	2.5
Limonitic concretions	2.5
Alkali	2.5
Chert that disintegrates in 5 cycles of the soundness test	2.5

C. General Requirements for Fine Aggregate. For fine aggregate calculate each individual sieve fraction soundness loss and ensure that the fractional size does not exceed 13.0 percent for all surface courses, intermediate courses, and any asphalt concrete course directly below an open graded friction course. Should the sample contain less than 10 percent of any of the sizes specified in AASHTO T104 Section 5.1, that individual size shall not be held to the above maximum loss requirement.

D. Silicon Dioxide Requirements for Natural Sands for Item 424. Provide natural sands for Item 424 with at least 50 percent silicon dioxide by weight. Test for silicon dioxide content according to ASTM C146 or ASTM C114. Natural sands will be approved on the following basis:

Percent by Weight, SiO_2	Status of Source Approval
> 55 %	Valid for two years from date approved [1]
50 – 55 %	Valid for one year from date approved [1]
< 50 %	Not approved [2]

[1] If a notable change in the properties of the aggregate originating from the affected source is determined from quality assurance testing, then a retest may be performed prior to the original expiration date. The Laboratory will make the determination to retest.

[2] Retests may be requested for materials falling below the 50% threshold; however, all requests must be supported by current test data from an AASHTO or CCRL accredited laboratory.

The Laboratory will maintain a list of approved sources.

703.06 Sand Cover (407 and 408).

A. Furnish sand cover consisting of natural sand or sand manufactured from stone or ACBFS.

B. Sieve analysis.

Sieve Size	Total Percent Passing
No. 4 (4.75 mm)	90 to 100
No. 50 (300 µm)	7 to 40
No. 200 (75 µm)	0 to 10

703.07 Mineral Filler.

A. Furnish mineral filler consisting of limestone dust, portland cement, or other inert mineral matter. Ensure the mineral filler is thoroughly dry and free from lumps.

B. Sieve analysis.

Sieve Size	Total Percent Passing
No. 30 (600 µm)	100
No. 50 (300 µm)	95 to 100
No. 200 (75 µm)	65 to 100

703.08 Granulated Slag.

A. Furnish Granulated Slag (GS) consisting of glassy, granular materials formed when molten blast furnace slag or electric-furnace slag is rapidly chilled, as by immersion in water. The Department may reject material containing mill waste, cinders, large pieces of ungranulated slag, or other matter foreign to the production of slag in the normal operation of the blast furnace or electric furnace.

Furnish material of such nature that it will compact to the satisfaction of the Engineer.

B. Sieve analysis.

Sieve Size	Total Percent Passing
2 inch (50 mm)	100
1 inch (25 mm)	85 to 100
No. 100 (150 µm)	0 to 15

703.10 Screenings.

A. Furnish screenings for No. 10 size gravel, stone, or ACBFS. Where crushed material is specified, ensure that it is crushed from material larger than the 1/2-inch (12.5 mm) sieve.

B. Physical properties.

	Maximum
Loss, sodium sulfate soundness test	15 %

703.11 Structural Backfill for 611 Bedding and Backfill. Furnish structural backfill for 611 bedding and backfill consisting of CCS, gravel, natural sand, sand manufactured from stone, foundry sand, ACBFS, or RPCC.

Furnish ACBF Slag according to Supplement 1027.

The use of RPCC is permitted without wear testing or sodium soundness testing requirements if the Contractor provides information proving the material met this specification at the time of its original incorporation. The use of RPCC is not permitted in conjunction with aluminum pipe or aluminum coated steel pipe. Ensure that the RPCC use does not contain more than two percent steel.

Reclaimed asphalt concrete is not allowed for any bedding or backfill materials.

Use foundry sand if the material meets these requirements and meets the requirements of the Ohio EPA, Division of Surface Water, Policy 400.007 "Beneficial use of Non-Toxic Bottom Ash, Fly Ash and Spent Foundry Sand and Other Exempt Waste," and all other regulations. Ten days before using foundry sand on the project, submit written permission from the Ohio EPA to the Engineer. Instead of written permission from the Ohio EPA, the Contractor may elect to have an independent consultant prequalified by ODOT in remedial design environmental site assessment review the proposed usage. The consultant will provide all documentation utilized to ensure that the proposed usage is according to all Ohio EPA regulations. Ensure that the consultant coordinates all EPA required meetings, documentation, and testing requirements. Ensure that the consultant certifies this to the Department.

A. Structural Backfill Type 1 and 3.

1. Furnish Type 1 structural backfill that meets the gradations of Items 304, 411, or 617, except 0 to 20 percent may pass the No. 200 sieve. Furnish Type 3 structural backfill that meets the gradations of Size No. 57 or 67 from Table 703.01-1.

2. Physical properties.

Percent of wear, Los Angeles test, maximum (CCS or washed gravel)	50 %
Loss, sodium, sulfate soundness test, maximum	15 %
Percent by weight of fractured pieces (one or more faces), minimum (Type 3 only)	90 %

Deleterious substances shall not exceed the following:

Material Type	Percent by weight
Shale and shaly material	5.0
Chert, that disintegrates in 5 cycles of the soundness test	5.0

Ensure that the portion of the material passing through the No. 40 (425 µm) sieve has a maximum liquid limit of 25 and a maximum plasticity index of 6.

Crush gravel for Type 3 from material retained on the 1/2 inch (12.5 mm) sieve.

B. Structural Backfill Type 2.

1. Furnish Type 2 structural backfill that meets the gradations of 703.05.A. Standard Gradation, 703.02.A, or one of the well graded gradations below:

Sieve Size	Type A	Type B
	Total Percent Passing	
2 1/2 inch (63 mm)	–	100
1 inch (25.0 mm)	–	70 to 100
3/4 inch (19.0 mm)	100	–
3/8 inch (9.5 mm)	80 to 100	–
No. 4 (4.75 mm)	60 to 100	25 to 100
No. 8 (2.36 mm)	45 to 95	–
No. 40 (425 µm)	–	10 to 50
No. 50 (300 µm)	7 to 55	–
No. 200 (75 µm)	0 to 15	0 to 15

2. Physical properties:

Percent of wear, Los Angeles test, maximum (CCS or gravel)	50 %
Loss, sodium sulfate soundness test, maximum	15 %

Ensure that the portion of the material passing through the No. 40 (425 mm) sieve has a maximum liquid limit of 25 and a maximum plastic index of 6.

703.13 Coarse Aggregate for Items 305, 451 and 452. In addition to the requirements of 703.02, the following aggregate requirements apply.

When the total combined quantity of the listed items is greater than 10,000 square yards (8000 m2), provide size No. 57 or 67 from Table 703.01-1. If the total combined quantity of the listed items is less than 10,000 square yards (8000 m2), then provide one of the following sizes from Table 703.01-1: No. 7, 78, 8, 57, or 67.

If gravel or limestone No. 57 or 67 size is selected in either of the above cases, then ensure that the coarse aggregate incorporated into the concrete is tested according to ODOT Supplement 1024.

Ensure that the validity of results of freeze thaw-resistance testing is as outlined below:

Average Total Percent Expansion[1]	Status of Source Approval
0.000 to 0.010	Valid for four years from date approved[2]
0.011 to 0.020	Valid for two years from date approved[2]
0.021 to 0.030[4]	Not Approved, one retest allowed[3]
> 0.030[4]	Not Approved, no retesting allowed[3]
[1] As measured at 350 cycles.	
[2] If a notable change in the properties of the aggregate originating from the affected source is determined from quality control testing, a retest of freeze-thaw resistance may be requested before the original expiration date. The Laboratory will make the determination to retest.	
[3] Except as noted, the Department will not retest the material unless the producer of the material sends a written request to the Department with substantiation that significant changes in operation have been made (e.g., new processing equipment, material from a new ledge, etc.).	
[4] If the average total percent expansion is greater than 0.020, but the durability is greater than or equal to 100, the department may accept the source for two years.	

The Laboratory will maintain a list of approved sources.

703.14 Non Pavement Open-Hearth, Electric Arc Furnace, and Basic Oxygen Furnace Steel Slag Aggregate Use. Provide steel slag according to the following requirements.

1. Non-confined Applications. When using OH, EAF, and BOF slag in applications where the steel slag will not be confined, ensure that the slag meets the requirements in 703.14.A (deleterious substances and crushing), and in 703.14.B (aging and stockpiling requirements). Recycled steel slag from Department or non-Department projects may be used in applications where the recycled steel slag will not be confined.

2. Confined Applications. When using OH, EAF, and BOF slag in applications where the steel slag will be confined, ensure the steel slag meets all requirements of 703.14. The use of recycled steel slag from Department or non-Department projects is not allowed in confined applications.

A. Deleterious Substances (soft pieces). Deleterious substances include soft lime, lime oxide,or magnesia agglomerations or any foreign materials prone to rapid disintegration under construction processing and weathering conditions.

Furnish steel slag with less than 3 percent deleterious substances (soft pieces) by weight. The Department will use Supplement 1029 (hand crushing of soft pieces) to determine the soft pieces.

Crushing of steel slag is not allowed.

B. Aging and Stockpiling Requirements. Stockpile and age all steel slag as follows:

1. Grade and stockpile the material into maximum size piles of 25,000 ton (23,000 metric tons). Before and during the stockpiling operation, add water to these materials to provide a uniform moisture content not less than their absorbed moisture. Ensure that the stockpile is maintained in a moist condition during the required stockpiling period.

2. Ensure that the producer mixes the stockpile when the outside surface of the pile has crusted over. The Department will inspect the stockpile every 2 months to ensure no crusting occurs. Do not mix frozen stockpile material. Suspend the aging period when the stockpile is frozen for more than one month.

3. Ensure that this aging period is at least 6 months in duration and starts over if any new material is added to the pile during the aging period.

C. Identification of Steel Slag. Clear, definitive, and undisputable identification of the proposed material being steel slag is required.

The producer will show the Department evidence that the material supplied is steel slag. This information will consist of, but is not limited to, the following:

1. Steel producer.
2. Production dates.
3. Production rates.
4. Stockpiling dates.
5. Type of steel furnace(s).
6. All known Department and non-Department projects where the material was previously used.

This identification of steel slag and the source may be supplemented by other information approved by the Department or by using 10 years of good performance data. Ensure that the producer submits to the Department projects where the steel slag has been used without expansion or tufa problems. The Department will review the above projects as part of the identification approval process.

D. Tufa Performance Verification of Steel Slag. Tufa is a precipitate form of calcium carbonate that can clog up the underdrain systems. Some steel slag sources clog up underdrain systems and some do not. Tufa performance verification is based on field performance and Department's inspection of the underdrain systems.

Tufa performance verification is required.

Ensure that the producer submits past projects that are at least 10 years old that used the proposed steel slag source to the Department. The Department may consider projects that are less than 10 years old for tufa performance verification if it can be determined by the Department that the age of the steel slag incorporated in the project was 10 years old or greater. Ensure the producer supplies the Department

with construction plans with the underdrains and underdrain outlets marked on the plans, or other suitable method, approved by the Department, showing the underdrain system. Ensure the producer marks the underdrain outlets in the field for inspection. The Department will inspect the underdrain systems for tufa deposits. If tufa deposits are found in the outlets or in the underdrain system, the Department will reject the steel slag source.

E. Expansion Testing of Steel Slag. After the aging and stockpiling requirements are met, expansion testing is required for steel slag.

Perform expansion testing according to Pennsylvania Department of Transportation PTM No. 130, the ODOT equivalent to this test or expansion testing acceptable to the Department.

Ensure that the producer hires an independent AASHTO accredited and Department approved laboratory to perform at least half of the expansion testing. At the producer's option, up to half of the required expansion testing may be performed by the producer's laboratory. The Laboratory will observe the expansion testing and approve each independent and producer laboratory.

Perform expansion testing for every 2500 tons (2300 metric tons) or fraction thereof of the material stockpiled in accordance with 703.14.B. For steel slag less than 10 years old, retain a spilt portion of the expansion sample. Reduce the split sample to 5 lbs (2500 g) and test for total percent MgO by X-Ray florescence and total percent periclase (hard burned MgO) by X-Ray diffraction.

The maximum allowable total expansion for each test is less than 0.50 percent. If any one test fails in the stockpile, the Department will reject the entire stockpile.

When sampling for expansion, ensure that the producer notifies the Department at least 48 hours before the sampling. The Department will verify that the sample came from the correct stockpile and take independent split samples, if required.

Submit the expansion test data and a suitably presented summary of the expansion test data to the Department for approval. Submit X-Ray florescence and X-Ray diffraction data to the Department. The Department reserves the right to perform independent testing to verify the laboratory results at any time.

The Department expansion test data takes precedence over the producer or independent laboratory expansion testing results in the event of a conflict. The Department will make the final determination on all conflicting data.

If the material fails the expansion testing, then stockpile the material for a minimum of two additional months from the date of last sampling and retest for expansion. Only materials that pass the expansion test are approved for use.

703.16 Suitable Materials for Embankment Construction. Natural soil, natural granular material, granular material types, slag material, brick, shale, rock, random material, RAP, RPCC, or PCS as further defined below are suitable for use in embankment construction. The Engineer will submit samples of soils not identified from the plan subsurface investigation, from borrow sources or materials appearing questionable in the field.

Furnish ACBFS according to Supplement 1027.

Furnish RPCC with the reinforcing steel cut to a maximum length of 1 inch (25 mm) outside the pieces.

Ensure that pieces of RAP do not exceed 4 inches (100 mm) in the largest dimension.

Furnish steel slag according to 703.14.

When using steel slag, RPCC, or RAP, completely blend it with at least 30 percent natural soil or natural granular material.

When using coal, completely blend it with natural soil or natural granular materials. Make at least 90 percent of the blend natural soil or natural granular materials.

A. Natural Soils. Furnish natural soils as defined in 203.02.I and classified as Department Group Classifications A-4-a, A-4-b, A-6-a, A-6-b, and A-7-6 as further defined below: Furnish soils with a maximum dry density of at least 90 pounds per cubic foot (1450 kg/m^3).

Do not use soils having a liquid limit more than 65 or soils identified as Department Group Classifications A-5, or A-7-5 in the work.

B. Granular Embankment Materials. Furnish natural granular materials as defined in 203.02.H and classified as Department Group Classifications A-1-a, A-1-b, A-3, A-3-a, A-2-4, A-2-6, or A-2-7.

Do not use granular material classified as A-2-5.

C. Granular Material Types. Furnish CCS, gravel, ACBFS, durable sandstone, durable siltstone, GS, or blended natural soil or natural granular materials blended with OH, BOF, EAF, or RPCC as detailed above. Furnish durable sandstone and siltstone with a slake durability index greater than 90 percent according to ASTM D 4644.

Except for GS, furnish the following gradations for the granular material types, by weight:

1. Granular Material, Type A. Furnish material having less than 25 percent by weight of the grains or particles passing the No. 200 (75 µm) sieve.

2. Granular Material Type B. For Item 204, furnish the gradation of Items 304, 411, or 617. For Item 203, furnish the gradation of Items 304, 411, or 617 except 0 to 20 percent will be allowed to pass the No. 200 (75 µm) sieve.

3. Granular Material Type C. Furnish well graded material that meets the following gradation:

Sieve Size	Total Percent Passing
3 inch (75 mm)	100
2 inch (50 mm)	70 to 90
1/2 inch (12.5 mm)	30 to 60
No. 200 (75 µm)	0 to 13

4. Granular Material Type D. Furnish the gradation of 100 percent passing the 8 inch (200 mm) sieve, less than 60 percent passing the 3 inch (76 mm) sieve, less than 40 percent passing the 3/4 inch (19 mm) sieve, and 0 to 20 percent passing the No. 200 (75 µm) sieve.

5. Granular Material Type E. Furnish any of the coarse aggregates from No. l through 67 inclusive on Table 703.01-1.

6. Granular Material Type F. Furnish material according to the following:

a. Well graded material.
b. A gradation with a top size from 8 inches (200 mm) to 3 inches (76 mm) and a bottom size of No. 200 (75 µm) sieve.
c. An evenly graded material between the top and bottom size.
d. Compactable, stable, and serves the intended use.

D. Shale. Furnish shale as defined in 203.02 and as further defined below. Ensure that the shale is tested for durability to determine whether the shale is durable or nondurable shale. Test the shale according to the following procedure:

1. Obtain a piece of shale that is typical and representative of the rest of the shale. The size of the piece should be about 6 inches (150 mm). If a 6-inch (150 mm) sample is not available, then the shale is nondurable.

2. Place the piece of shale in a bucket of water. Examine the deterioration or slaking of the shale after 48 hours. If the shale has deteriorated, then the shale is nondurable.

3. If the shale has not deteriorated after being in water for 48 hours, then break down the shale over a 3/4 inch (19.0 mm) sieve by hand pressure. If 75 percent or less of the shale is retained on the 3/4 inch (19.0 mm), then the shale is nondurable.

4. If more than 75 percent of the shale is retained on the 3/4 inch (19.0 mm) sieve or, then perform a field test for durability. The field test for durability consists of compacting the shale with six passes of a steel drum roller which has a minimum compaction force of 500 pounds per lineal inch (57 kN/mm) of roller drum width. Provide documentation to the Engineer to verify the roller meets the compaction force requirement.

a. If more than 40 percent of the shale breaks down, by visual inspection, then the shale is nondurable.
b. If less than 40 percent of the shale breaks down, by visual inspection, then the shale is durable.

703.17 Aggregate Materials for 304. Furnish aggregate that is CCS, crushed gravel, crushed ACBFS, or steel slag.

Furnish steel slag according to 703.14

Furnish ACBFS according to Supplement 1027.

Determine aggregate acceptance before incorporation into the work based on samples taken from stockpiles.

A. Furnish CCS, crushed gravel, crushed ACBFS, and steel slag that meets the following gradation:

Sieve Size	Total Percent Passing
2 inch (50 mm)	100
1 inch (25.0 mm)	70 to 100
3/4 inch (19.0 mm)	50 to 90
No. 4 (4.75 mm)	30 to 60
No. 30 (600 µm)	9 to 33
No. 200 (75 µm)	0 to 15 [1]
[1] Furnish steel slag that has 0 to 10 percent passing through the No. 200 (75µm) sieve	

Furnish gravel used under Item 304 that is crushed from material retained on the 1/2 inch (12.5 mm) sieve.

B. Furnish CCS, crushed gravel, ACBFS, and steel slag that meets the physical property requirements:

Percent of wear, Los Angeles test, maximum (CCS or crushed gravel)	50 %
Loss, sodium sulfate soundness test, maximum	15 %
Percent by weight of fractured pieces (one or more faces), minimum	90 % [1]
[1] Does not apply to steel slag	

Ensure deleterious substances in CCS, crushed gravel, and ACBFS do not exceed the following:

Material Type	Percent by weight
Shale and shaly material	5.0
Chert, that disintegrates in 5 cycles of the soundness test	5.0

Ensure that the portion of the material passing through the No. 40 (425 µm) sieve has a maximum liquid limit of 25 and a maximum plasticity index of 6.

703.18 Materials for Items 410, 411, and 617. Furnish CCS, gravel, ACBFS, GS, OH slag, BOF slag, EAF slag, RPCC, or RAP for materials.

If RPCC and RAP are used, provide the following information:

1. Specification item that the material was originally constructed under.
2. The applicable material requirements of the original construction item.

If the original construction requirements meet or exceed the requirements of this specification, then the shale, sodium soundness and Los Angeles abrasion test for RAP and RPCC may be waived. The plastic index and clay requirements are not required for RAP. Use RPCC that is free of steel.

Furnish OH, BOF, and EAF slag according to 703.14

Use ACBFS according to Supplement 1027.

Furnish GS according to 703.08.

A. Gradations. Furnish for Items 617, 410, and 411 RAP materials according to the following gradation:

Sieve Size	Total Percent Passing
1 1/2 inch (37.5 mm)	100
3/4 inch (19.0 mm)	80 to 100
3/8 inch (9.5 mm)	60 to 90
No. 4 (4.75 mm)	30 to 90
No. 30 (600 µm)	3 to 20

Except for GS and RAP, use the following gradations for Items 410, 411, and 617.

Furnish materials for Item 410 according to one of the following gradations:

	Type A	Type B	Type C
Sieve Size	Total Percent Passing		
1 1/2 inch(37.5 mm)	100	100	Size No. 4 or 57 from Table 703.01-1
1 inch (25.0 mm)	90 to 100	75 to 100	
3/4 inch (19.0 mm)	60 to 100	60 to 100	
3/8 inch (9.5 mm)	40 to 60	35 to 75	
No. 4 (4.75 mm)	15 to 30	30 to 60	

Do not use RAP for Type C material.

Furnish materials for Item 411 according to the following gradation:

Sieve Size	Total Percent Passing
1 1/2 inch(37.5 mm)	100
1 inch (25.0 mm)	75 to 100
3/4 inch (19.0 mm)	60 to 100
3/8 inch (9.5 mm)	35 to 75
No. 4 (4.75 mm)	30 to 60
No. 30 (600 µm)	7 to 30
No. 200 (75 µm)	3 to 15

Furnish materials for Item 617 according to the following gradation:

Sieve Size	Total Percent Passing
1 inch (25.0 mm)	100
3/4 inch (19.0 mm)	60 to 100
3/8 inch (9.5 mm)	35 to 75
No. 4 (4.75 mm)	30 to 60
No. 30 (600 µm)	9 to 33
No. 200 (75 µm)	0 to 15

B. Physical properties.

	Item 410	Item 411	Item 617
Percent of wear, Los Angeles test, maximum	50 %	–	–
Loss, sodium sulfate soundness test, maximum	–	15 %	–
Percent by weight of fractured pieces (one or more faces), minimum	–	–	90 %
Gravel used, portion retained on a No. 4 (4.75 mm) sieve (one or more faces) minimum crushed	–	40 %	–
Maximum plasticity index of material passing No. 40 (425 μm) sieve	–	6	–

Deleterious substances shall not exceed the following:

	Percent by weight		
Material Type	**Item 410**	**Item 411**	**Item 617**
Shale and shaly material	–	5 % [1]	12 %
Clay	10 %	–	–

[1] Where the major portion of the material in a coarse aggregate, from a source on record at the Laboratory, has shown the characteristics of acquiring a mud-like condition when tested for soundness, test it for soundness and ensure that the maximum loss is 5 percent.

703.19 Rock and Aggregate Materials for Item 601.

A. Crushed Aggregate Slope Protection and Filter Aggregate for Dump Rock Fill. Furnish crushed gravel, limestone, sandstone, RPCC, ACBFS, OH slag, BOF slag, or EAF slag for crushed aggregate slope protection and filter aggregate for dump rock fill.

Use ACBFS slag according to Supplement 1027.

Use OH, BOF, and EAF slag according to 703.14

Furnish Size No. 1 or 2 from Table 703.01-1, or according to the following gradation for crushed aggregate slope protection:

Sieve Size	Total Percent Passing
4 inch (100 mm)	100
3 1/2 inch (90 mm)	90 to 100
2 1/2 inch (63 mm)	25 to 90
1 1/2 inch (37.5 mm)	0 to 25
3/4 inch (19.0 mm)	0 to 10

For a filter for rock channel protection, use Size No. 3 or 4 from Table 703.01-1.

Physical properties.

Percent of wear, Los Angeles Test, maximum (except for ACBFS)	50 %
Loss, sodium sulfate soundness test, maximum (except for RPCC)	15 %
Percent by weight of fractured pieces minimum (CCS or gravel)	90 %
Loss for RPCC, AASHTO T 103 Soundness of Aggregates by Freezing and Thawing	20 % [1]
[1] Use Method C using 25 cycles.	

B. Dumped Rock Fill and Rock Channel Protection. Furnish gravel, broken recycled portland cement concrete (RPCC), broken sandstone, broken siltstone, and broken limestone for dumped rock fill and rock channel protection. Furnish sandstone, siltstone, and limestone that is free of laminations, seams, and fractures, or injury due to blasting.

Except for RPCC, test for soundness according to ASTM D 5240. Use materials having a maximum 30 percent single slab loss and a maximum 20 percent cumulative loss. Slab heights and lengths will be a minimum of 8 inches. For RPCC, test for soundness according to AASHTO T 103 as stated in 703.18.A.

The Department may waive testing when the stone source has a known durability history.

Do not use thin, slab-like pieces, or any pieces having a dimension larger than 36 inches (1 m). Do not use RPCC with reinforcing steel protruding more than 1 inch (25 mm) beyond the outside surface of the concrete pieces.

Furnish dumped rock fill and rock channel protection materials consisting of the four material types defined below:

1. Type A material has at least 85 percent of the total material by weight larger than an 18-inch (0.5 m) but less than a 30-inch (0.8 m) square opening and at least 50 percent of the total material by weight larger than a 24-inch (0.6 m) square opening. Furnish material smaller than an 18-inch (0.5 m) square opening that consists predominantly of rock spalls and rock fines, and that is free of soil.

2. Type B material has at least 85 percent of the total material by weight larger than a 12-inch (0.3 m) but less than a 24-inch (0.6 m) square opening and at least 50 percent of the total material by weight larger than an 18-inch (0.5 m) square opening. Furnish material smaller than a 12-inch (0.3 m) square opening that consists predominantly of rock spalls and rock fines, and that is free of soil.

3. Type C material has at least 85 percent of the total material by weight larger than a 6-inch (150 mm) but less than an 18-inch (0.5 m) square opening and at least 50 percent of the total material by weight larger than a 12-inch (0.3 m) square opening. Furnish material smaller than a 6-inch (150 mm) square opening that consists predominantly of rock spalls and rock fines, and that is free of soil.

4. Type D material has at least 85 percent of the total material by weight larger than a 3-inch (75 mm) but less than a 12-inch (0.3 m) square opening and at

least 50 percent of the total material by weight larger than a 6-inch (150 mm) square opening. Furnish material smaller than a 3-inch (75 mm) square opening that consists predominantly of rock spalls and rock fines, and that is free of soil.

703.20 Aggregate for Water Quality Structures.

A. Fine Aggregate.

1. Furnish fine aggregate consisting of washed natural sand, washed sand manufactured from stone or gravel, or washed lightweight sand prepared by expanding products such as clay, diatomite, shale, or slate.

2. Sieve analysis.

Sieve Size		Total Percent Passing
3/8 inch	(9.5 mm)	100
No. 4	(4.75 mm)	95 to 100
No. 8	(2.36 mm)	65 to 100
No. 16	(1.18 mm)	40 to 80
No. 30	(600 µm)	20 to 60
No. 50	(300 µm)	5 to 30
No. 100	(150 µm)	0 to 10
No. 200	(75 µm)	0 to 1

B. Coarse Aggregate.

1. Furnish coarse aggregate consisting of washed gravel, washed CCS, or washed lightweight aggregate prepared by expanding products such as clay, diatomite, shale, or slate.

2. Gradation. Furnish any of the coarse aggregates from Size No.1 through No.10 inclusive on Table 703.01-1. Ensure that the percent by weight of material passing the No. 200 (75 µm) sieve in the course aggregate does not exceed 1percent.

3. Physical properties.

Percent of wear, Los Angeles test, maximum	40 %

704 MASONRY UNITS

704.01 Clay or Shale Brick. Furnish clay or shale brick conforming to ASTM C 32, with the following modifications:

4.1 Furnish bricks of such size and shape as to allow their incorporation in the structure in conformance with the specified dimensions of the structure.

6.1 Furnish materials according to the Department's QPL.

704.02 Concrete Brick. Furnish concrete brick according to ASTM C 55, with the following modifications:

4.1.1 and 4.1.2 Use cement conforming to 701 Portland Cement.

4.2 Use aggregate that conforms to the quality requirements of 703.02.

8.1 Furnish materials according to the Department's QPL.

8.2 Sample and test the brick according to ASTM C 140. Furnish bricks of such size and shape as to allow their incorporation in the structure in conformance with the specified dimensions of the structure. Furnish bricks that have a rectangular cross-section with square corners. Ensure that the ends, edges, and one face are plain surfaces.

704.03 Concrete Masonry Blocks. Furnish concrete masonry blocks conforming to ASTM C 139, with the following modification:

4.1.1 and 4.1.2 Use cement conforming to 701 Portland Cement.

7.1 Furnish materials according to the Department's QPL.

7.2 Furnish blocks of such size and shape as to allow their incorporation in the structure in conformance with the specified dimensions of the structure.

705 CONCRETE INCIDENTALS

705.01 Glass Fiber Reinforced Polymer (GFRP) Dowel Bars. Furnish round and straight fiber reinforced polymer (GFRP) dowel bars. Ensure resin used to manufacture the GFRP bars consists of an epoxy vinyl ester resin. Ensure the glass fiber used is ECR glass which meets ASTM D578. Ensure that the minimum glass fiber content is 70 percent by weight. Furnish dowel bars of a type meeting the dimensional requirements of the standard construction drawings. Provide certified test data according to 101.03 with each shipment.

705.03 Preformed Fillers. Furnish preformed fillers according to AASHTO M 153 or AASHTO M 213, with the following modification:

5.7 For materials manufactured as described in 4.1.1 and 4.1.2, ensure that the producer certifies to the Engineer that the asphalt content is at least 35 percent by weight of the filler.

Or furnish semi-rigid closed-cell polypropylene foam preformed fillers according to ASTM D 8139.

Furnish materials according to the Department's QPL.

705.04 Hot Applied Joint Sealer, Furnish hot applied joint sealer conforming to ASTM D 6690, Type II Use this material as the primer for Type 3 membrane.

705.05 Burlap Cloth. Furnish burlap cloth according to AASHTO M 182, Class 2.

705.06 Sheet Materials for Concrete Curing. Furnish sheet materials conforming to ASTM C171 for moisture loss and reflectance only.

705.07 Liquid Membrane-Forming Compounds for Curing Concrete. Furnish liquid membrane-forming compounds conforming to ASTM C 309, with the following modification:

5.3 In addition - liquid membrane-forming compounds will have a minimum solids content of 25% .

6.1 Water Retention - Liquid membrane-forming compound, when tested in accordance with 10.1, shall have a water loss of not more than: 0.15 kg/m^2 @ 24 hours and 0.40 kg/m^2 @ 72 hours.

7.1 Reflectance - Type 2 curing compound will have a minimum daylight reflectance of 65%.

10.4 In addition - Mix Type 2 curing compound until uniform in color and consistency, and then pour into a glass graduated cylinder (Kimax 150 ml) to the 150 ml mark. The Type 2 curing compound should have a rate of settling such that its uniformly white portion as visible to the eye is not less than 145 ml at 2 hours and not less than 125 ml at 24 hours after filling the Kimax cylinder . The test should be performed at 73.0 ± 3.5 ºF (23 ± 2 ºC). During this test the glass cylinder should be stoppered and left undisturbed.

11.1 In addition, Equip the containers for Type 2 white pigmented liquid membrane forming compounds with mechanical agitators. Assign each container in any batch or lot, a number as the container is being filled.

Furnish materials according to the Department's QPL.

705.10 Air-Entraining Admixtures. Provide air-entraining admixtures conforming to AASHTO M 154. Conform to Supplement 1001 for approval.

Furnish materials according to the Department's QPL.

705.11 Preformed Elastomeric Compression Joint Seal for Concrete.

A. General. Provide preformed elastomeric compression joint seal conforming to ASTM D 2628, with the following modifications:

5.1 Ensure that the size and design is as shown on the plans.

7.2 The Engineer will perform inspection at the project site.

7.3 If sampled, provide a minimum of 3 feet (1.0 m), with all manufacturers' markings,

12.1 In addition, ensure that markings are every 1 foot (305 mm). Use lubricants recommended by the seal manufacturer to install preformed compression seals.

B. Qualification. Obtain Department approval of each design, shape, width, depth, web, and shell thickness before use. Submit drawings of the seals showing all dimensions and dimension tolerances and weight per foot (meter) with the request for approval.

Furnish materials according to the Department's QPL.

705.12 Chemical Admixture for Concrete. Provide chemical admixtures conforming to ASTM C 494. Ensure that the minimum relative durability factor is 90.

Furnish materials according to the Department's QPL.

705.13 Neoprene Sheeting. Provide material conforming to the following:

Test Description	Specification	Requirement
Thickness (inch)	ASTM D751	0.094±0.01
Breaking Strength, Grab (lb)	ASTM D751	700 × 700 (long. × trans.)
Adhesive Strip, 1" wide × 2" long (lb)	ASTM D751	9
Burst Strength (psi)	ASTM D751	1400
Heat Aging, 70 hr., 212 °F, 180° bend without cracking	ASTM D2136	No cracking of coating
Low temperature brittleness, 1 hr., -40 °F, bend around ¼" mandrel	ASTM D2136	No cracking of coating

Furnish material according to the Department's QPL.

705.15 High Molecular Weight Methacrylate (HMWM) Resin. Provide low viscosity, non-fuming high molecular weight methacrylate (HMWM) resin conforming to the following:

Viscosity	Less than 25 cps (Brookfield viscometer, Model RVT with UL adaptor or Model LVF, # spindle and UL adaptor C @ 77 °F (25 °C) (ASTM D 2849)
Density	Greater than 8.4 lb/gal Ca 77 °F (25 °C) (ASTM D 2849)
Flash Point	Greater than 200 °F (93 ºC) (PenskyMartens CC) (ASTM D 93)
Vapor Pressure	Less than 1.0 mm Hg C @ 77 °F (25 °C) (ASTM D 323)
TG (DSC)	Greater than 135 °F (58 °C) (ASTM D3418)
Shelf Life	Must be 1 year minimum at manufacturers recommended environmental considerations
Gel Time	Greater than 40 min, 100 g mass (ASTM D 2471) (thin film)
Percent Solids	Greater than 90% by weight
Bond Strength	Greater than 1500 psi (10.5 MPa) (ASTM C 882)

Furnish materials according to the Department's QPL.

705.20 Non Shrink, Non Metallic Materials. Provide anchoring materials for installing anchor bolts, dowels and similar material in concrete which are non-shrink, 100% solids, two part (resin and hardener), fast setting, and moisture insensitive.

A. Provide certified test data according to 101.03 showing compliance with the following requirements. Include manufacturer's installation and application requirements.

Test Description	Specification	Requirements	Notes
Bond Strength (dry)	ASTM C882	2 day, Min. 1800 psi	Average of three samples [1]
Bond Strength after subjected to 300 cycles freeze/thaw testing	ASTM C882 specimens subjected to ASTM C666 Method B testing and the tested conforming to C882	Min. 1600 psi	Average of three samples [1]
Heat Deflection	ASTM D648	7 day, Min. 130 ºF	
Linear Coefficient of Shrinkage	ASTM C531	% Max. 0.005	
Pullout Strength Test (dry)	See procedure below	24 hours, Min. Load 22,500 lbs	Average of three cylinders in dry condition
Pullout Strength Test (wet)	See procedure below	24 hours, Min. Load 22,500 lbs	Average of three cylinders in wet condition

[1] A total of six samples will be made under C882. Three of the C882 samples will be tested under C666 Method B and those samples tested.

Pullout Strength Test Procedure. Perform pullout strength tests under dry and wet conditions as follows:

1. Dry Condition (epoxy steel)

Cast three concrete test blocks or cylinders, a minimum of 6 inches (150 mm) in width or diameter by 12 inch (300 mm) in depth. Use concrete with a compressive strength of 4000+/- 500 psi at 28-days Center a 6 3/4 inch (170 mm) deep hole, drilled the diameter required by the manufacturer's requirements for installing a No. 6 (20M) rebar, in the block or cylinder by drilling or forming. Dry the hole surfaces and clean the holes following manufacturer instructions. Fill the hole with adhesive materials according to manufacturer recommendations. Insert a No. 6 (20M) deformed reinforcing bar 30 inches (760 mm) long, cleaned and degreased, into the hole. Hold and center the bar perpendicular to the concrete surface in the grout-filled hole during the curing period.

2. Wet Condition (epoxy steel)

Cast three concrete test blocks or cylinders, a minimum of 6 inches (150 mm) in width or diameter by 12 inch (300 mm) in depth. Use concrete with a compressive strength of 4000+/- 500 psi at 28-days. Center a 6-3/4 inch (170 mm) deep hole, drilled the diameter required by the manufacturer's requirements for installing a No. 6 (20M) rebar, in the blocks or cylinders by drilling or forming. Wet the hole's surfaces prior to applying the anchoring material by filling the hole with water and letting stand for five minutes. Turn the samples over for two minutes to allow the excess water to drain from the hole, Turn all samples over to the upright positions and immediately fill hole with adhesive materials according to manufacturer recommendations. Insert a No. 6 (20M) deformed reinforcing bar 30 inches (760 mm) long, cleaned and degreased into the hole. Hold and center the bar

perpendicular to the concrete surface in the adhesive-filled hole during the curing period.

Cure the specimen at 77 ± 5 °F (25 ± 3 °C) for 24 hours.

For the pullout strength test, apply an axial load to the bar at a rate of 1/2 inch (13 mm) per minute until the bar pulls out of the specimen, or the concrete block or cylinder cracks or spalls. Record the failure mode and applied load.

B. Epoxy materials will also conform to ASTM C881, Type IV, Grade 3, Class A, B or C.

Supply the anchoring material in non-reactive containers and with their SDS. Label containers with the name of the product, the manufacturer, the shelf life expiration date, the batch number, quantity, and provide application instructions.

Maintain storage areas between 40 and 100 °F (5 and 38 °C).

Only use materials on the Department's QPL.

705.21 Quick Setting Concrete Mortar. Provide prepackaged mortar material that requires the addition of water only.

Only use materials meeting the following criteria:

A. Capable of being extended 50 percent by dry mortar weight with aggregate meeting the following requirements:

(1) Gradation requirements of Table 703.01-1 for No. 8, 89, 9, or a combination thereof.

(2) AASHTO M 43, Maximum Passing No. 200 (75 μm) sieve - Not to exceed 0.2 percent.

(3) AASHTO T 84 and T 85, Absorption - Not more than 2 percent.

(4) AASHTO T 104, Soundness Loss - Not more than 2 percent.

a. Ensure that the material meets the following requirements:

Test		Type 1	Type 2
Compressive Strength ASTM C 109[2]			
psi (MPa)	@ 1 Hour	100 (0.7)	2000 (14)
	@ 3 Hour	250 (1.7)	---
	@ 24 Hours	2000 (14)	5000 (34)
	@ 7 Days	---	7000 (48)
Compressive Strength ASTM C 39[1],[2]			
psi (MPa)	@ 1 Hour	100 (0.7)	(2000) (14)
	@ 3 Hour	150 (1.0)	---
	@ 24 Hours	1000 (10)	3500 (24)
	@ 7 Days	---	6000 (41)
Initial Set Time (min) ASTM C 266[2]		5 Minutes	10 Minutes
Bond Strength, ASTM C 882[1]			
psi (MPa)	@ 24 Hours	1000 (7)	1000 (7)
	@ 7 Days	1500 (11)	1500 (11)
Flexural Strength ASTM C 78[1]			
psi (MPa)	@ 4 Hour	---	200 (1.4)
	@ 3 Day	650 (4.5)	500 (3.4)
Freeze and Thaw ASTM C 666 (use either Procedure B or A) [1]			
Procedure B (350 Cycles) Durability Factor		80%	80%
Procedure A (300 Cycles) Durability Factor		79%	79%
[1] Extend test specimens 50 percent by dry mortar weight with aggregate.			
[2] Test the mortar as received with the addition of water. Ensure that the amount of water is designated on the packing container by the manufacturer.			

B. Prequalify the material by placing and having the material evaluated conforming to Supplement 1070 for 2 years. At the end of the 2 year rating the material will meet the following criteria:

1. Percentage debonding/delamination ≤ 5%

2. Percentage spalling ≤ 5%

3. Mid panel average crack width ≤ 1/16 inch (1.6 mm) and total length of mid panel cracks ≤ 20 feet (6.1 m) total length

4. Edge Cracking/debonding average crack width ≤ 1/16 inch (1.6 mm) and total length of cracks ≤ 12 feet (3.6 m)

Furnish the Laboratory with a certified copy of test results from a recognized laboratory showing compliance with the requirements of this specification for item A. Furnish the laboratory written documentation of the method of surface preparation and any primers, adhesives, or activators used in the field test. Those will become requirements of the material system for subsequent approval or use. A

recognized laboratory is one that is regularly inspected by the Cement and Concrete Reference Laboratory of the National Institute of Standards and Technology.

Provide quick setting concrete mortar packaged in strong moisture resistant paper bags or other suitable containers capable of withstanding shipping, normal handling, and storage without breakage. The package will protect the material from deterioration when stored in a dry condition for a period of 1 year. Each package or container must display information regarding the minimum nominal yield and instructions for mixing. Calculate volumetric yield determinations using the manufacturers' recommended water content.

Furnish materials listed on the Department's QPL.

705.22 Nonshrink Mortar. Provide nonshrink mortar conforming to ASTM C 1107, with the following modification:

9.1 In addition, ensure that the fluidity of the grout at the maximum water content is at least equal to a flowable mixture as defined in ASTM C 827, Section 8.2.2 and that the minimum flow is 125 @ 5 drops of the flow table in 3 seconds.

Furnish materials according to the Department's Approved List.

705.23 Concrete Sealers

A. Provide an Epoxy-Urethane sealer incorporating a two component cross linked urethane and conforming to the following requirements:

1. Absorption - ASTM C642 (non-air entrained concrete). Proportion and mix concrete according to ASTM C672. Sealed concrete, under total immersion, will not exceed 1.0% after 48 hours or 2.0% after 50 days

2. Scaling Resistance - ASTM C672 A rating of "No scaling" after 100 cycles on the sealed concrete (non-air entrained concrete) as compared to "Severe Scaling" on untreated concrete.

3. NCHRP 244, Series 11 - Cube Test

   3.1 Weight gain - not to exceed 25% of untreated cube

   3.2 Absorbed chloride - not to exceed 25% of untreated cube

4. NCHRP 244, Series IV - Southern Exposure

   4.1 Absorbed chloride - not to exceed 10% of untreated concrete

5. Volatile Organic Compounds (VOC) maximum, ASTM D 3960, 3.33 lbs./gal(0.399 g/ml), as applied

Record and report the application rate (square footage/gallon) of sealer during the tests.

Provide test data from an approved independent testing facility. The sealer manufacturer funds the testing costs.

Furnish the test data, a one quart (one liter) sample, and the SDS to the Office of Materials Management (OMM). OMM will determine material acceptance.

Furnish materials according to the Department's QPL.

B. Provide an Non-Epoxy sealer conforming to the following requirements:

1. Absorption - ASTM C642 (non-air entrained concrete). Proportion and mix concrete according to ASTM C672. Sealed concrete, under total immersion, will not exceed 1.0% after 48 hours or 2.0% after 50 days

2. Scaling Resistance - ASTM C672 A rating of "No scaling" after 100 cycles on the sealed concrete (non-air entrained concrete) as compared to "Severe Scaling" on untreated concrete.

3. NCHRP 244, Series 11 - Cube Test

3.1 Weight gain - not to exceed 25% of untreated cube

3.2 Absorbed chloride - not to exceed 25% of untreated cube

4. NCHRP 244, Series IV - Southern Exposure

4.1 Absorbed chloride - not to exceed 10% of untreated concrete

5. Volatile Organic Compounds (VOC) maximum, ASTM D 3960, 3.33 lbs./gal(0.399 g/ml), as applied

Record and report the application rate (square footage/gallon) of sealer during the tests.

Provide test data from an approved independent testing facility. The sealer manufacturer funds the testing costs.

Furnish the test data, a one quart (one liter) sample, and the SDS to the OMM. OMM will determine material acceptance.

Furnish materials according to the Department's QPL.

705.24 Soluble Reactive Silicate. Provide a soluble reactive silicate (SRS) that is a blend of Na/K/FlxSiOx (sodium, potassium, fluoro or other silicate), surfactants, polymers, and stabilizers capable of thoroughly saturating and sealing concrete. The treatment system will meet the following performance requirements:

A. Scaling Resistance - Treated concrete, abraded by sufficient wire brushing to break any film remaining on the surface after drying, will pass ASTM C 672, Scaling Resistance test with a rating of 2 - "Slight to Moderate Scaling" after 50 cycles (non-air entrained concrete) as compared to a rating of 5 – "Severe Scaling" on untreated concrete.

B. Absorption - The absorption of treated concrete under total immersion will not exceed 1.0 percent after 48 hours or 2.0 percent after 50 days (ASTM C 642, non-air entrained concrete). Concrete should be proportioned and mixed in accordance with ASTM C 672.

C. Skid resistance - The skid resistance of treated concrete pavement will not be reduced by more than 10 percent as compared to the same untreated pavement. ASTM E 274 using ASTM E 501 ribbed tire at 40 mph (64 kph), five test average.

D. AASHTO T 259 as modified. The standard T 259 Resistance of Concrete to Chloride Ion Penetration will; be modified as follows:

In addition to section 3.1, intentionally break the specimens so they have a full depth crack through the middle of the slab.

Install section 3.2 dams around the perimeter of the re-assembled, cracked, concrete specimens. Caulk around the perimeter of the dam to assure that only the crack and the concrete will allow water to pass through or be absorbed. After assembly, measure the crack width at three locations and report the crack width.

Perform the ponding of 3.4 until the 3% solution comes through the specimen's crack. Record and report the time required for the solution to appear through the specimen's crack. Remove the solution from the specimens and re-dry according to 3.3 (T 259).

After drying apply the SRS to the specimen's top surface at the manufacturer's recommended rate of application. Record and report the rate of application. Air dry the SRS coated dammed sample specimens for 7 days. After 7 days, re perform the ponding with 3% chloride solution until solution comes through the specimen's crack or 14 days. Record the time the till the ponded solution comes through the crack.

Acceptable SRS materials will have a value of 2 or more when the ponding time before SRS application is divided into the ponding time after SRS application.

Sections 3.5, 3,6, 4.1,4.2 and 5.1 (of T 259) will not apply.

Have tests performed by an approved independent testing facility acceptable to the Department.

Submit test data and a one quart (one liter) a technical data sheet and the SDS to the OMM for approval

Furnish materials according to the Department's QPL.

705.25 Gravity-Fed Resin. Provide non shrink, non metallic resin conforming to ASTM C 881, Type 1, Grade 1, Class B or C and the following:

The maximum viscosity at the lowest allowable temperature will be 250 cps. The manufacturer will provide test data to verify the viscosity at the lowest temperature for the class for which it is to be approved.

A minimum average sand retention of 95.0% for three samples tested according to the Sand Penetration Test Method described below.

Show no signs of cracking, debonding or insufficient curing during the sand penetration test

A. Sand Penetration Test Method. This test will be conducted with the following equipment and materials:

1. 4 oz (118 ml) wax coated paper cup. Maximum top diameter 2 5/16" (59 mm); bottom diameter 1 11/16" (43 mm); height 2 3/8" (960 mm).
2. 20 - 30 grade sand (ASTM C 778)
3. 1 Pint non-absorbent container
4. 8 oz (240 ml) plastic cup

5. Stirring stick or spatula
6. Scale accurate to 0.1 g
7. Disposable gloves
8. Stop watch
9. Thermometer
10. Paint brush

B. Perform the test as follows

1. Assure the material and the room is at 73 °F (23 °C)
2. Determine and record the tare weight of the paper cup (1).
3. Introduce 100.0 grams of 20 - 30 graded sand (2) into the paper cup.
4. Record the weight of the cup and the sand.
5. Consolidate the sand in the cup by lifting the cup approximately ½ " (13 mm) and dropping 25 to 30 times. Then lightly tap the sides of the cup 25 to 30 times with the fingers. The sample may also be placed on a vibrating table for 10 to 15 seconds.
6. Measure enough material into the 8 oz plastic cups (4) to make at least a 200 g sample.
7. Combine the components into the non-absorbent container (3) and mix according to the manufacturer's recommendations using a spatula or stirring stick (5).
8. Pour 40.0g of material over the sand and record the weight of the resin, cup and sand
9. Allow the resin, sand and cup to set undisturbed for 24 hours at 73 °F (23 °C). Re-weigh the resin, cup and sand
10. Remove as much of the paper cup from around the hardened resin and sand matrix as possible. Lightly brush any loose sand from the matrix. Weigh the hardened matrix.
11. Calculate the percent of sand retained, F, as follows:

$$F = [E / (D - A)] \times 100$$

Where,

A = Tare weight of paper cup (g)
B = Weight of cup and sand (g)
C = Weight of fresh mixture of resin, cup and sand (g)
D = Weight of cured mixture of resin, cup and sand (g)
E = Weight of resin sand matrix as measured in step 10 (g)

12. Report the average of three specimens mixed separately
13. Also calculate and report the percent loss due to curing G as follows:

$$G = [(D - C) / (C - B)] \times 100$$

14. Examine the sand / resin matrix for signs of insufficient curing and bond, or excessive shrinkage.

Material Approval. The manufacturer will provide certified test data verifying compliance with the above requirements; technical data sheet; current SDS for the material; 1 gallon sample; and a letter certifying that the product formulation will not be altered without notification to the Department and OMM.

OMM will determine materials acceptance and include in the Department's QPL.

Furnish materials according to the Department's QPL.

705.26 Epoxy injection Resin. Provide epoxy injection resin capable of application, positive adherence and strength development when applied to moist or wet surfaces at temperatures of 33 °F (1 °C) and above.

Use products that contain 100% solids material and no non-reactive diluents, solvents or other fillers. Provide materials that meet the following requirements:

A. The injection material will meet the requirements of ASTM C 881 Type IV, Grade 1 and Class B or C and have a maximum viscosity of 600 cps at the lowest ambient material and substrate temperature to be used.

B. The paste materials will meet the requirements of ASTM C 881 Type I, Grade 3 and Class B or C.

Material Approval. The manufacturer of the materials is responsible for prequalifying the material and submitting the following to the OMM:

An Independent certified test data indicating that the materials, when mixed according to the manufacturer's recommendations, meet the requirements listed above.
Manufacturer's technical data sheet for the paste and injection materials.
SDS for paste and injection materials.
1 Gallon Sample or 2 kits of the injection materials

Furnish materials according to the Department's QPL.

705.27 Carbonate Micro-Fines for use in Portland Cement Concrete. Provide carbonate micro-fines (CMF) according to Supplement 1016 and ASTM C1797, except modify Type C according to the properties shown in Table 705.27-1 below:

TABLE 705.27-1 CHEMICAL AND PHYSICAL REQUIREMENTS

Parameter	Type C
MgCO3, %	≥43
Sum of CaCO3 + Mg CO3, % by mass	≥ 98
Methylene blue value (mg/g)	≤ 3
Particle size distribution,	**minimum % passing**
No. 20 (850 μm) sieve	100
No. 50 (300 μm) sieve	80-100
No. 100 (150 μm) sieve	
No. 200 (75 μm) sieve	10-90
No. 325 (45 μm) sieve	5-70

705.28 Glass Fiber Reinforced Polymer (GFRP) Deformed Bars. Furnish GFRP reinforcement according to ASTM D7957 except as noted. Furnish deformed bars of a type meeting the dimensional requirements of the standard construction drawings. Furnish certified material according to Supplement 1138.

The Mean Tensile Modulus of Elasticity limit (ASTM D7957 Table 1) shall meet or exceed 8700 ksi (60 GPa).

The Mean Ultimate Tensile Strain limit (ASTM D7957 Table 1) shall meet or exceed 1.4%.

The Tensile Modulus of Elasticity limit (ASTM D7957 Table 2) shall meet or exceed 8700 ksi (60 GPa).

The Ultimate Tensile Strain limit (ASTM D7957 Table 2) shall meet or exceed 1.4%.

The Minimum Guaranteed Ultimate Tensile Force (ASTM D7957 Table 3) shall be as follows:

Bar Designation No	Minimum Guaranteed Ultimate Tensile Force Kip (kN)
2 (M6)	6.1 (27)
3 (M10)	13.2 (59)
4 (M13)	27.6 (123)
5 (M16)	36.6 (163)
6 (M19)	51.9 (231)
7 (M22)	68.5 (305)
8 (M25)	89.9 (400)
9 (M29)	124 (550)
10 (M32)	138 (615)

705.29 Synthetic Fibers for use in Portland Cement Concrete. Provide Type III synthetic, non-metallic fibers in accordance with ASTM C 1116 and ASTM D7508 with the following exceptions:

Aspect Ratio – Length/Equivalent Diameter,
min ..... 70 – 100

max…… 100
Tensile Breaking Strength, min .. 70,000 psi (482 MPa)
Modulus of Elasticity, min ..... 800,000 psi (5515 MPa)
Length: ....1.5 inches (38 mm) to 2.25 inches (57 mm)
Dosage Rate:
.....Minimum of 4 pounds per cubic yard (2.4 kg/m^3)

Test the synthetic fibers in accordance with ASTM C 1609 and ASTM C 1579 utilizing an AASHTO-accredited laboratory for portland cement concrete materials and in accordance with the following table

REQUIRED HARDENED FIBER REINFORCED CONCRETE PROPERTIES

Physical Test	Specification	Requirement
Equivalent Flexural Strength Ratio ($R_{T,150}^{150}$)*	ASTM C 1609	Minimum of 25%
Crack Reduction Ratio (CRR)	ASTM C 1579	Minimum reduction >85%

*Test specimens when the concrete flexural strength at first crack (f_1) is a minimum of 600 psi.
For 6 inch x 6 inch x 20 inch fiber reinforced beam the maximum required net deflection value of L/150 of the 18 inch span length is 0.12 inch.

Furnish materials according to the Department's QPL.

706 CONCRETE AND CLAY PIPE

706.01 Non-Reinforced Concrete Pipe. Provide non-reinforced concrete pipe conforming to ASTM C 14 (ASTM C 14M), with the following modifications:

5.3 Does not apply.

6.2 Provide cementitious materials conforming to 701, except 701.07.

6.3 Provide aggregate conforming to the quality requirements of 703.02.

10.2 Ensure that the manufacture furnishes the number of pipe shown in the "Minimum Requirements for Sampling Materials" table, section 700.

10.3 In addition, perform external load crushing strength tests with hard rubber blocks on wood strips with plaster of paris bedding fillets.

13 Perform inspection at the project site. Obtain random samples from materials delivered to the project site or at other locations designated by the Laboratory. Ensure that the manufacturers of these materials are certified by the Office of Materials Management according to Supplement 1074.

15 Ensure that the markings also include "P" to denote non-reinforced pipe.

Testing Equipment. Ensure that every manufacturer furnishing concrete pipe under these Specifications furnishes all facilities and personnel needed to perform the tests.

706.02 Reinforced Concrete Circular Pipe. Provide reinforced concrete circular pipe conforming to ASTM C 655 (ASTM C 655M), with the following modifications:

Ensure that the minimum D-Load of the reinforced concrete pipe is as follows:

Size		Minimum	D-Load
12 in	(300 mm)	2000 lb	(100 kg)
15 in	(375 mm)	2000 lb	(100 kg)
18 in	(450 mm)	1250 lb	(62.5 kg)
21 in	(525 mm)	1250 lb	(62.5 kg)
24 in	(600 mm)	1250 lb	(62.5 kg)
27 in or larger	(675 mm or larger)	1000 lb	(50 kg)

1 In addition, ensure that this pipe is circular reinforced concrete pipe with circular or elliptical reinforcement, with and without quadrant and "S" strip reinforcement.

4.1 The acceptability of the pipe design is determined according to Section 10. All designs in ASTM C 76 (ASTM C 76M), Tables 2 through 5, inclusive, are accepted designs with the 0.01-inch (0.3 mm) crack D-loads as follows:

	D-Load	
ASTM C 76 (ASTM C 76M) Table No.	0.01-inch Crack	(0.3 mm) Crack
2 (Class II)	1000 lb	(50 kg)
3 (Class III)	1350 lb	(65 kg)
4 (Class IV)	2000 lb	(100 kg)
5 (Class V)	3000 lb	(140 kg)

All designs in Tables 706.02-1 through 706.02-4 are accepted designs with noted 0.01-inch (0.3 mm) crack and ultimate D-loads. For intermediate D-loads, in Tables 2 through 5 of ASTM C 76 (ASTM C 76M), steel areas for a given wall thickness may be interpolated between Tables 2 and 3, 3 and 4, and 4 and 5 for a size and D-load as accepted designs. Where different concrete strengths are listed in the tables, use the higher concrete. In addition, steel areas, interpolated as above between Table 706.02-1 and Table 706.02-2, 36-inch (900 mm) through 108-inch (2700 mm) using the higher concrete strength, and interpolation of the circumferential steel between Table 706.02-3 and Table 706.02-4 using the wall thickness and stirrup designs in Table 706.02-4, are accepted designs. Pipe manufactured according to an accepted pipe design will be accepted, at the option of the Laboratory, according to the basis of acceptance described in Section 4.1.1 or 4.1.2.

Provide reinforced concrete pipe with S-stirrups according to Figure 706.02-1 (Figure 706.02-1M) and the following requirements:

1. Provide steel conforming to 709.08, 709.10, 709.11, or 709.12. Ensure that the wall thickness, amount of circular reinforcement, S-stirrup system, and concrete strength comply with Tables 706.02-2, 706.02-3, and 706.02-4. Ensure that the spacing center-to-center of adjacent inner rings of circumferential reinforcement in a cage does not exceed 4 inches (102 mm) for pipe up to and

including pipe having a 4 inches (102 mm) wall thickness or exceed wall thicknesses for larger pipe and in no case exceed 6 inches (152 mm).

2. Ensure that each line of S-stirrups have a continuous "S" shape extending longitudinally from end to end of the pipe. Ensure that they extend from the inner cage toward the outer surface of the pipe for a distance not less than the minimum amplitude. Ensure that S-stirrups pass around and are in contact with each inside circumferential member of the inner cage. Ensure that each line of S-stirrups lie essentially in a plane passing through the longitudinal axis of the pipe.

3. Where more than one length of stirrup material is used per line, make a lap round one circumferential member of the inner cage. Ensure that the ends of "S" shaped stirrups at splices include an outer bend. Do not use more than three lengths of "S" material in a line and ensure that the minimum length of a section of S-stirrups is 30 inches (0.76 m).

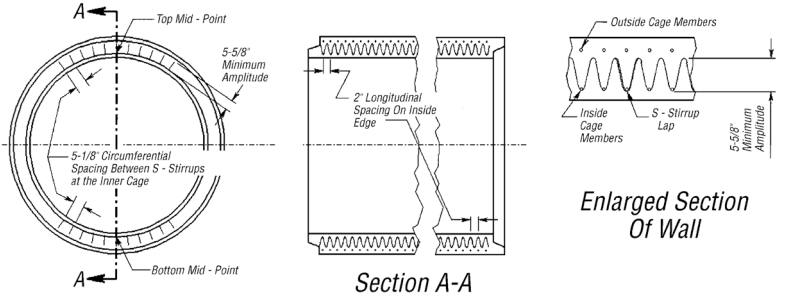


Figure 706.02-1 Illustrative Example of S-Stirrup Support System for 0.01-inch Crack D-load 3000, 102-inch diameter Pipe Minimum Area Per Support 0.053 square inch, 11 Lines Spaced @ 5 1/8 inches. For other classes and sizes, see Tables 706.02-2, 3, and 4.

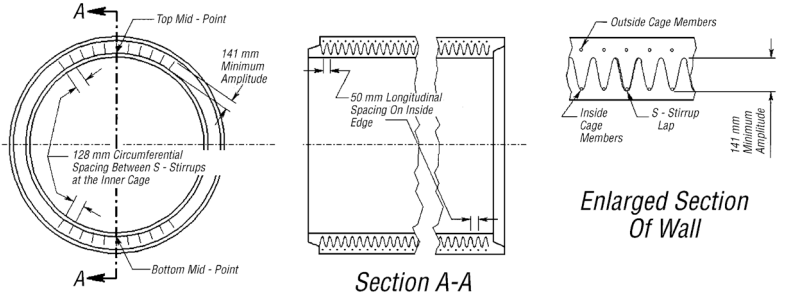


Figure 706.02-1M Illustrative Example of S-Stirrup Support System for 0.3 mm Crack D-Load 140.0, 2550 mm diameter Pipe Minimum Area per Support 34 mm^2, 11 Lines Spaced @ 128 mm. For other classes and sizes, see Tables 706.02-2M, 3M, and 4M.

TABLE 706.02-1

0.01-inch Crack D-Load 1000
Ultimate Strength D-Load 1500

Internal Dia. of Pipe (inch)	Wall Thick-ness (inch)	Circular Reinforcement in Circular Pipe (in²/ft of pipe)	
		Inner Cage	Outer Cage
Reinforcing Steel 709.11 or 709.12 Only Concrete Strength, 4000 psi			
36	4	0.09	0.07
42	4 1/2	0.11	0.08
48	5	0.13	0.09
54	5 1/2	0.16	0.12
60	6	0.19	0.14
66	6 1/2	0.21	0.16
72	7	0.23	0.17
78	7 1/2	0.25	0.19
84	8	0.29	0.21
90	8	0.33	0.24
96	8 1/2	0.37	0.26
Reinforcing Steel 709.11 or 709.12 Only Concrete Strength, 5000 psi			
102	8 1/2	0.41	0.28
108	9	0.47	0.30
All Permitted Reinforcing Steel, Concrete Strength, 5000 psi			
114	9 1/2	0.56	0.42
120	10	0.61	0.46
126	10 1/2	0.65	0.49
132	11	0.70	0.52
144	12	0.80	0.60

TABLE 706.02-1M

0.3 mm Crack D-Load 50.0
Ultimate Strength D-Load 75.0

Internal Dia. of Pipe (mm)	Wall Thick-ness (mm)	Circular Reinforcement in Circular Pipe (cm²/m of pipe)	
		Inner Cage	Outer Cage
Reinforcing Steel 709.11 or 709.12 Only Concrete Strength, 27.6 MPa			
900	100	1.9	1.5
1050	113	2.3	1.7
1200	125	2.8	1.9
1350	138	3.4	2.5
1500	150	4.0	3.0
1650	163	4.4	3.4
1800	175	4.9	3.6
1950	188	5.3	4.0
2100	200	6.1	4.4
2250	200	7.0	5.1
2400	213	7.8	5.5
Reinforcing Steel 709.11 or 709.12 Only Concrete Strength, 34.5 MPa			
2550	213	8.7	5.9
2700	225	9.9	6.4
All Permitted Reinforcing Steel, Concrete Strength, 34.5 MPa			
2850	238	11.9	8.9
3000	250	12.9	9.7
3150	263	13.8	10.4
3300	275	14.8	11.0
3600	300	16.9	12.7

4.1.1 In addition, test the pipe designs covered by Tables 706.02-1, 706.02-2, 706.02-3, and 706.02-4 and ASTM C 76 (ASTM C 76M), Tables 2 through 5, and interpolated designs by the three-edge bearing method. When the test load on the pipe reaches 115 percent of the required 0.01-inch (0.3 mm) crack D-load without developing a 0.01-inch (0.3 mm) or larger crack, accept the test specimen for strength. If any test specimen fails to pass this test, but attained the 0.01-inch (0.3 mm) crack, continue the test until the ultimate D-load is reached.

4.1.2 In addition, accept pipe 54 inches (1350 mm) and larger in diameter covered by Tables 706.02-1, 706.02-2, 706.02-3, and 706.02-4, and ASTM C 76 (ASTM C 76M), Tables 2 through 5, and interpolated designs according to Section 12 and the following requirements:

1. When pipe from a plant has been approved by the Laboratory for a specified design and pipe from the same plant has wall and steel area not less than the approved pipe.

2. When it has been established that two or more plants have complied with the above requirements for the class and size under consideration, and the plant under consideration has established compliance with the above requirements for an adjacent size, and the wall and steel area are not less than the pipe tested at the two plants.

6.1.2.1 Provide cement according to 701.

6.1.2.2 Provide fly ash according to 701.13

6.1.3 Provide aggregates conforming to the quality requirements of 703.02.

6.1.5 Provide steel according to 709.08, 709.10, 709.11, or 709.12.

6.2.4 Ensure that no more than two holes are cast, drilled, or otherwise neatly made in the shell of each piece of pipe for the purpose of handling or laying. Taper the holes unless drilled, and before backfilling, fill the tapered holes with portland cement mortar, precast concrete plugs secured with portland cement mortar, or a device on the Department's Approved List specifically designed for filling the hole. Fill drilled holes with portland cement mortar.

7.1 and 7.3 In addition, perform strength tests using methods described in ASTM C 497 (ASTM C 497M).

10.1 In addition, ensure that pipe designs covered by Tables 706.02-1, 706.02-2, 706.02-3, and 706.02-4 and ASTM C 76 (ASTM C 76M) Tables 2 through 5 have the number of samples selected as shown in the "Minimum Requirements for Sampling Materials" table for each size, class, and production lot (pipe of the same size and class made from the same materials and by the same process and approximately the same production date) for test.

TABLE 706.02-2

0.01-inch Crack D-Load 1350 Ultimate Strength D-Load 2000

Internal Dia. of Pipe (inch)	Wall Thick-ness (inch)	Circular Reinforcement in Circular Pipe (in²/ft of pipe)		S-Stirrups				
		Inner Cage	Outer Cage	Minimum Area per Support Element	Number of Lines [1]	Longitudinal Spacing	Circumferential Spacing on Inner Cage	Minimum Amplitude of Stirrups [2]
Reinforcing Steel 709.11 or 709.12 Only Concrete Strength, 4000 psi								
36	4	0.12	0.09					
42	4 1/2	0.15	0.11					
48	5	0.17	0.12					
54	5 1/2	0.21	0.16					
60	6	0.26	0.20					
66	6 1/2	0.30	0.21					
72	7	0.35	0.24					
78	7 1/2	0.40	0.27					
84	8	0.47	0.30					
Reinforcing Steel 709.11 or 709.12 Only Concrete Strength, 5000 psi								
90	8	0.64	0.35					
96	8 1/2	0.80	0.40					
102	8 1/2	0.96	0.44					
108	9	1.07	0.47	(in²)		(inch)	(inch)	(inch)
All Permitted Reinforcing Steel, Concrete Strength, 5000 psi								
114	9 1/2	0.69	0.52	0.041	5	2	6 1/8	6 5/8
120	10	0.74	0.55	0.041	5	2	6 1/2	7 1/8
126	10 1/2	0.79	0.60	0.041	5	2	6 7/8	7 5/8
132	11	0.85	0.64	0.041	5	2	7 1/4	8 1/8
144	12	0.97	0.73	0.041	5	2	8	9 1/8

[1] Number of lines in the table indicates the number of longitudinal lines required in each top and bottom portion of the pipe. The area of each support element in a pipe is two times the cross-sectional area of the S-stirrups wire used. There shall be an equal number of these lines of S-stirrups on either side of the mid-point of both the top and bottom of the pipe. See Figure 706.02-1.

[2] The amplitude is the overall width of the line of stirrups.

TABLE 706.02-2M

0.3 mm Crack D-Load 65.0 Ultimate Strength D-Load 100.0

Internal Dia. of Pipe (mm)	Wall Thick-ness (mm)	Circular Reinforcement in Circular Pipe (cm²/m of pipe)		S-Stirrups				
		Inner Cage	Outer Cage	Minimum Area per Support Element	Number of Lines [1]	Longitudinal Spacing	Circumferential Spacing on Inner Cage	Minimum Amplitude of Stirrups [2]
Reinforcing Steel 709.11 or 709.12 Only Concrete Strength, 27.6 MPa								
900	100	2.5	1.9					
1050	113	3.2	2.3					
1200	125	3.6	2.5					
1350	138	4.4	3.4					
1500	150	5.5	4.2					
1650	163	6.4	4.4					
1800	175	7.4	5.1					
1950	188	8.5	5.7					
2100	200	9.9	6.4					
Reinforcing Steel 709.11 or 709.12 Only Concrete Strength, 34.5 MPa								
2250	200	13.5	7.4					
2400	213	16.9	8.5					
2550	213	20.3	9.3					
2700	225	22.6	9.9	(mm²)		(mm)	(mm)	(mm)
All Permitted Reinforcing Steel, Concrete Strength, 34.5 MPa								
2850	238	14.6	11.0	26	5	50	156	168
3000	250	15.7	11.6	26	5	50	165	181
3150	263	16.7	12.7	26	5	50	175	194
3300	275	18.0	13.5	26	5	50	184	206
3600	300	20.5	15.5	26	5	50	203	232

[1] Number of lines in the table indicates the number of longitudinal lines required in each top and bottom portion of the pipe. The area of each support element in a pipe is two times the cross-sectional area of the S-stirrups wire used. There shall be an equal number of these lines of S-stirrups on either side of the mid-point of both the top and bottom of the pipe. See Figure 706.02-1M.

[2] The amplitude is the overall width of the line of stirrups.

TABLE 706.02-3

0.01-inch Crack D-Load 2000 Ultimate Strength D-Load 3000

Internal Dia. of Pipe	Wall Thick-ness	Circular Reinforcement in Circular Pipe (in²/ft of pipe)		S-Stirrups				
				Minimum Area per Support Element	Number of Lines [1]	Longitudinal Spacing	Circum. Spacing on Inner Cage	Min. Amplitude of Stirrups [2]
(inch)	(inch)	Inner Cage	Outer Cage	(in²)		(inch)	(inch)	(inch)
Concrete Strength, 5000 psi								
78	7 1/2	0.69	0.52	0.029	11	2	4 1/8	4 5/8
84	8	0.74	0.56	0.029	11	2	4 5/8	5 1/8
90	8	0.85	0.63	0.031	11	2	4 5/8	5 1/8
96	8 1/2	0.91	0.69	0.034	11	2	5 1/8	5 5/8
102	8 1/2	1.02	0.77	0.041	12	2	5 1/8	5 5/8
108	9	1.07	0.80	0.045	11	2	5 5/8	6 1/8
114	9 1/2	1.02	0.77	0.048	11	2	6 1/8	6 5/8
120	10	1.10	0.82	0.051	11	2	6 1/2	7 1/8
126	10 1/2	1.17	0.88	0.055	11	2	6 7/8	7 5/8
132	11	1.25	0.94	0.058	11	2	7 1/4	8 1/8
144	12	1.42	1.07	0.065	11	2	8	9 1/8

[1] and [2] Refer to footnotes in Table 706.02-2

TABLE 706.02-3M

0.3 mm Crack D-Load 100 Ultimate Strength D-Load 150

Internal Dia. of Pipe	Wall Thick-ness	Circular Reinforcement in Circular Pipe (cm²/m of pipe)		S-Stirrups				
				Minimum Area per Support Element	Number of Lines [1]	Longitudinal Spacing	Circum. Spacing on Inner Cage	Min. Amplitude of Stirrups [2]
(mm)	(mm)	Inner Cage	Outer Cage	(mm²)		(mm)	(mm)	(mm)
Concrete Strength, 34.5 MPa								
1950	188	14.6	11.0	19	11	50	105	117
2100	200	15.7	11.9	19	11	50	117	130
2250	200	18.0	13.3	20	11	50	117	130
2400	213	19.3	14.6	22	11	50	130	143
2550	213	21.6	16.3	26	12	50	130	143
2700	225	22.6	16.9	29	11	50	143	156
2850	238	21.6	16.3	31	11	50	156	168
3000	250	22.3	17.4	33	11	50	165	181
3150	263	24.8	18.6	35	11	50	175	194
3300	275	26.5	19.9	37	11	50	184	206
3600	300	30.1	22.6	42	11	50	203	232

[1] and [2] Refer to footnotes in Table 706.02-2M

TABLE 706.02-4

0.01-inch Crack D-Load 3000 Ultimate Strength D-Load 3750

Internal Dia. of Pipe (inch)	Wall Thick-ness (inch)	Circular Reinforcement in Circular Pipe (in²/ft of pipe)		S-Stirrups				
		Inner Cage	Outer Cage	Minimum Area per Support Element	Number of Lines [1]	Longitudinal Spacing	Circum. Spacing on Inner Cage	Minimum Amplitude of Stirrups [2]
Concrete Strength, 6000 psi								
6	1 3/4	0.07	--					
8	1 3/4	0.07	--					
10	1 3/4	0.07	--					
54	5 1/2	0.86	0.62					
60	6	0.95	0.68	(in²)		(inch)	(inch)	(inch)
Concrete Strength, 5000 psi								
54	5 1/2	0.64	0.48	0.029	15	2	2 1/8	2 5/8
60	6	0.70	0.53	0.029	14	2	2 5/8	3 1/8
66	6 1/2	0.79	0.59	0.029	13	2	3 1/8	3 5/8
72	7	0.87	0.66	0.029	12	2	3 5/8	4 1/8
78	7 1/2	0.92	0.69	0.031	11	2	4 1/8	4 5/8
84	8	0.99	0.74	0.034	11	2	4 5/8	5 1/8
90	8	1.13	0.85	0.041	11	2	4 5/8	5 1/8
96	8 1/2	1.20	0.90	0.045	11	2	5 1/8	5 5/8
102	8 1/2	1.34	1.00	0.053	11	2	5 1/8	5 5/8
108	9	1.51	1.13	0.063	11	2	5 5/8	6 1/8
114	9 1/2	1.51	1.13	0.064	11	2	6 1/8	6 5/8
120	10	1.62	1.21	0.068	11	2	6 1/2	7 1/8
126	10 1/2	1.73	1.30	0.072	11	2	6 7/8	7 5/8
132	11	1.84	1.38	0.076	11	2	7 1/4	8 1/8
144	12	2.09	1.57	0.085	11	2	8	9 1/8

[1] and [2] Refer to footnotes in Table 706.02-2

TABLE 706.02-4M

0.3 mm Crack D-Load 140.0 Ultimate Strength D-Load 175.0

Internal Dia. of Pipe (mm)	Wall Thick-ness (mm)	Circular Reinforcement in Circular Pipe (cm²/m of pipe)		S-Stirrups				
		Inner Cage	Outer Cage	Minimum Area per Support Element	Number of Lines [1]	Longitudinal Spacing	Circum. Spacing on Inner Cage	Minimum Amplitude of Stirrups [2]
Concrete Strength, 41.4 MPa								
150	44	1.5	--					
200	44	1.5	--					
250	44	1.5	--					
1350	138	18.2	13.1					
1500	150	20.1	14.4	(mm²)		(mm)	(mm)	(mm)
Concrete Strength, 34.5 MPa								
1350	138	13.5	10.2	19	15	50	54	67
1500	150	14.8	11.2	19	14	50	37	79
1650	163	16.7	12.5	19	13	50	79	92
1800	175	18.4	14.0	19	12	50	92	105
1950	188	19.5	14.6	20	11	50	105	117
2100	200	21.0	15.7	22	11	50	117	130
2250	200	23.9	18.0	26	11	50	117	130
2400	213	25.4	19.1	29	11	50	130	143
2550	213	28.4	21.2	34	11	50	130	143
2700	225	32.0	23.9	41	11	50	143	156
2850	238	32.0	23.9	41	11	50	156	168
3000	250	34.3	25.6	44	11	50	165	181
3150	263	36.6	27.5	46	11	50	175	194
3200	275	38.9	29.2	49	11	50	184	206
3600	300	44.2	33.2	55	11	50	203	232

[1] and [2] Refer to footnotes in Table 706.02-2M

11.1 Perform compression tests on cores according to ASTM C 497 (ASTM C 497M).

11.3 Does not apply.

12 Perform inspection at the project site. Obtain random samples from material delivered to the project site or at other locations designated by the Laboratory.

16 Furnish materials from suppliers certified according to Supplement 1074.

17 In addition, after the capital letter "D," designate the D-load, the design wall thickness in millimeters (inches expressed as a decimal). Ensure that pipe with S-stirrups have the symbol "S". Ensure that pipe requiring axis orientation without lift holes (i.e., stirrup pipe, quadrant reinforced pipe, elliptically reinforced pipe) has the centerline of the crown of the pipe marked inside and outside with the symbol "TB". Mark pipe with quadrant steel with the symbol "Q". Mark pipe with elliptical

reinforcement with the symbol "E". Mark pipe with deformed wire reinforcement required in the design with the symbol "DF".

706.03 Reinforced Concrete Pipe, Epoxy Coated. Provide Type A reinforced concrete epoxy coated pipe conforming to 706.02 and Type B conforming to 706.04, with the following modification:

In the plant, prepare the interior barrel and joint surface areas of the concrete pipe to remove all forms of oil, laitance, and other deleterious materials and then line them with a high-build, polyamide-cured, two-component coal tar epoxy coating, Military Specification DOD-P-23236A (SH). Spray the lining compound to obtain a continuous and relatively uniform and smooth lining with a minimum dry film thickness of 0.03 inch (760 μm). Ensure that all coated pipe are free of surface irregularities such as air bubbles, delamination, lumping, sagging, blistering, pinholing, or porosity, in the coating film.

706.04 Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe. Provide reinforced concrete elliptical culvert, storm drain, and sewer pipe conforming to ASTM C 507 (ASTM C 507M), with the following modifications:

4.1 Delete Class HE-A. Table 706.04-1 includes additional design requirements.

5.1 All materials, processes of manufacture, and finished pipe are subject to inspection and approval by the Department. When directed by the Laboratory, the manufacturer will cut holes in sections of the finished pipe for inspection.

6.2.1 Provide cement according to 701, except 701.07.

6.2.2 Provide fly ash according to 701.

6.3 Provide aggregates conforming to the quality requirements of 703.02.

6.5 Provide steel according 709.08, 709.10, 709.11, or 709.12.

7.2 In addition, manufacture horizontal elliptical pipe HE-II and HE-III using the design requirements of Table 706.04-1.

8.1 In addition, ensure that pipe made in accordance with 706.04-1 has three lines of reinforcement of elliptical shape. Place the outer and inner lines of reinforcement so that the nominal protective covering of the concrete over the reinforcement in the barrel of the pipe is 1 inch (25 mm) subject to the variations permitted in Section 12.5. Ensure that the third or middle line is in contact with and fastened securely to the inner line at the vertical axis of the pipe both top and bottom and to the outer line at the horizontal axis on both sides. Ensure that the length of the middle line is the average of the length of the inner and outer line. Ensure that the middle line is of an elliptical shape and runs smoothly between the specified points of contact with the inner and outer lines.

10 Ensure that no more than two holes are cast, drilled, or otherwise neatly made in the shell of each piece of pipe for the purpose of handling or laying. Taper the holes unless drilled, and before backfilling, fill the tapered holes with portland cement mortar, precast concrete plugs secured with portland cement mortar, or a device on the Department's Approved List specifically designed for filling the hole. Fill drilled holes with portland cement mortar.

11.2 Select the specified number of pipe, as noted in the "Minimum Requirements for Sampling Materials" table, for the purpose of test at the plant and at random from the lot to be shipped or at the project site from the pipe delivered and that are pipe that would not otherwise be rejected under these Specifications. Test pipe according to Section 5.1.1 except the Laboratory may accept pipe 54 inches (1350 mm) and larger in diameter according to Section 5.1.2 and the following requirements:

1. When pipe from a plant has been approved by the Laboratory for a specified design, pipe from the same plant with wall and steel area not less than the approved pipe may be approved by means of tests on cores verifying absorption, strength, wall, and steel area.

2. When it has been established that two or more plants have complied with the above requirements for the class and size under consideration and the plant under consideration has established compliance with the above requirements for an adjacent size, and the wall and steel area are not less than the pipe tested at the two plants.

11.3.1 Ensure that the load to produce a 0.01-inch (0.3 mm) crack and the ultimate load as determined by ASTM C 497 (ASTM C 497M) three-edge bearing method, is not less than shown in Tables 1, 2, and 706.04-1. The ultimate strength test may be waived when the test load on the pipe reaches 115 percent of the required 0.01-inch (0.3 mm) crack D-load without developing a 0.01-inch (0.3 mm) or larger crack.

11.4 Perform compression tests for satisfying the minimum specified concrete strength requirement from cores drilled from the wall of the pipe. Ensure that the diameter of the core is such that the capped height to diameter or L/D ratio lies between one and two. Ensure that the cores are secured, prepared for testing, and tested by methods prescribed in the appropriate sections of ASTM C 497 (ASTM C 497M). Ensure that the compressive strength of each core tested is equal to or greater than the design strength of the concrete. If a core does not meet the required strength, test another core from the same pipe. If this core does not meet the required strength, the Department may reject the pipe. Make additional tests on other pipe to determine the acceptability of the lot. When the cores cut from a section of pipe successfully meet the strength test requirement, ensure that the core holes are plugged and sealed by the manufacturer in a manner such that the pipe section will meet all of the test requirements of these Specifications.

11.9 Does not apply.

11.10 Does not apply.

14 Perform inspection at the project site. Obtain random samples from material delivered to the project site or at other locations designated by the laboratory.

Ensure manufacturers of these materials are certified according to Supplement 1074.

16 In addition, place the plant location on each pipe, and for pipe manufactured to design requirements of 706.04-1 place the letter "A" after the pipe

class. Ensure that the markings are legible and indented in the pipe section or painted on with waterproof paint.

TABLE 706.04-1 DESIGN REQUIREMENTS FOR HORIZONTAL ELLIPTICAL PIPE

Equiv. Round Size (inch)	Rise (inch) × Span (inch)	Minimum Wall Thickness (inch)	Minimum Reinforcement (in²/ft)	
			HE-II	HE-III
			D-Loads	
			0.01 = 1000	0.01 = 1350
			Utl. = 1500	Utl. = 2000
78	63 × 98	8	3 lines totaling 0.87	3 lines totaling 1.23
84	68 × 106	8 1/2	3 lines totaling 0.97	3 lines totaling 1.33
90	72 × 113	9	3 lines totaling 1.03	3 lines totaling 1.43
96	77 × 121	9 1/2	3 lines totaling 1.13	3 lines totaling 1.54
102	82 × 128	9 3/4	3 lines totaling 1.23	3 lines totaling 1.70
108	87 × 136	10	3 lines totaling 1.43	3 lines totaling 1.85

The test load in lb/ft equals D-load × nominal inside span in feet. Concrete strength=5000 psi.

TABLE 706.04-1M DESIGN REQUIREMENTS FOR HORIZONTAL ELLIPTICAL PIPE

Equiv. Round Size (mm)	Rise (mm) × Span (mm)	Minimum Wall Thickness (mm)	Minimum Reinforcement (cm²/m)	
			HE-II	HE-III
			D-Loads	
			0.03 = 50.0	0.03 = 65.0
			Utl. = 75.0	Utl. = 100.0
1950	1585 × 2495	200	3 lines totaling 18.4	3 lines totaling 26.0
2100	1705 × 2690	213	3 lines totaling 20.5	3 lines totaling 28.2
2250	1830 × 2880	225	3 lines totaling 21.8	3 lines totaling 30.3
2400	1950 × 3070	238	3 lines totaling 23.9	3 lines totaling 32.6
2550	2075 × 3265	244	3 lines totaling 26.0	3 lines totaling 36.0
2700	2195 × 3455	250	3 lines totaling 30.3	3 lines totaling 39.2

The test load in kN/m equals D-load × nominal inside span in mm. Concrete strength=34.5 MPa.

706.05 Precast Reinforced Concrete Box Sections. Provide precast reinforced concrete box section conforming to ASTM C 1577, with the following modifications:

Ensure that manufacturers of precast concrete members are certified by the Laboratory according to Supplement 1073.

6.2.1 Provide cement according to 701, except 701.07.

6.2.2 Provide fly ash according to 701.

6.2.4.9 Provide Carbonate Micro-Fines according to 705.27 and Table 499.03-2.

6.3 Provide aggregates conforming to the quality requirements of 703.02.

6.5 Provide reinforcement according to 709.10 or 709.12. Provide longitudinal distribution reinforcement according to 709.01, 709.10 or 709.12.

7.1 For the following box sizes, span by rise, refer to ASTM C1577: 6x4, 5, 6; 7x4, 5, 6, 7; 8x4, 5, 6, 7, 8; 9x4, 5, 6, 7, 8, 9; 10x4, 5, 6, 7, 8, 9, 10; 11x4, 5, 6, 7, 8, 9, 10, 11; and 12x4, 5, 6, 7, 8, 9, 10, 11, 12 feet. For the following box sizes, span by rise, refer to SS940: 14x4, 5, 6, 7, 8, 9, 10; 16x4, 5, 6, 7, 8, 9, 10; 18x4, 5, 6, 7, 8, 9, 10; and 20x4, 5, 6, 7, 8, 9, 10 feet.

9.1 Provide hardened concrete that contains a minimum of 4 percent entrained air for wet-cast sections with spans less than 14 feet (4200 mm) and for all sections with spans 14 feet (4200 mm) and greater.

9.4 Lift holes are not permitted. Use handling devices that do not require a hole through the box.

10.1 Verify concrete strength using cylinders. Do not ship items before the design strength of the concrete is reached.

11.5 A minimum cover of 1/2 inch (13 mm) over both circumferential and longitudinal reinforcement is required at the mating surfaces of joints.

15 In addition, mark the identification of the plant on each box section. For box sections 14 feet (4200 mm) or greater, mark the reinforcing steel areas for the section on each box section. Place the manufacturers' name and required product information on the inside of the box section within the top one-half of the culvert.

706.051 Precast Reinforced Concrete Three-Sided Flat Topped Culverts. Provide precast concrete three-sided flat topped culverts according to ASTM C 1504, with the following modifications:

Provide flat deck culvert structures with a minimum clear span (measured normal to the structure at the bottom of the haunch) of 14 feet (4200 mm) and a minimum opening rise (measured from bottom of leg to bottom of deck at the centerline of the structure) of 4 feet (1200 mm); and a maximum clear span of 34 feet (10,200 mm) and maximum opening rising of 10 feet (3000 mm). Ensure that the minimum wall and deck thicknesses is 10 inches (250 mm) and 12 inches (300 mm) respectively, measured under the haunch normal to the structure and at the centerline of the span measured perpendicular to the structure.

Ensure manufacturers of precast concrete members are certified according to Supplement 1073.

5. Ensure the manufacturer submits design calculations, a structural load rating and shop drawings according to 611.04. Ensure the shop drawings include the following:

1. Load rate the structure according to the requirements of section 900 of the Department's Bridge Design Manual.
2. All material specifications.
3. All plan view.
4. All elevation view.
5. All headwall and wingwall attachment requirements.
6. All dimensions.

7. All maintenance of traffic phases.
8. All section sizes.
9. All design handling strength.

The manufacturer may modify an approved shop drawing and resubmit for approval to the Department.

Ensure that the shop drawings also include the following special information as required:

1. For top mounted guardrail, show the guardrail plate and bolt locations in the plan view. Ensure that holes are a minimum of 6 inches (150 mm) from a joint.

2. For side mounted guardrail, show additional reinforcing details according to the plan details.

6.2.1 Provide cement according to 701, except 701.07.

6.2.2 Provide fly ash according to 70113.

6.2.4.9 Provide Carbonate Micro-Fines according to 705.27 and Table 499.03-2.

6.3 Provide aggregates conforming to the quality requirements of 703.02.

6.4 Use chemical admixtures according to 705.12. Use a corrosion inhibitor unless epoxy coated reinforcing steel is used. An approved list of corrosion inhibiting admixtures is on file at the Laboratory. Manufacturers should recognize that the corrosion inhibitors and admixtures may have an effect on strength, entrained air content, workability, etc. of their concrete mixes. The manufacturers choice of one of these corrosion inhibitors does not alleviate meeting all design requirements of this structure.

6.4.1 Provide air-entraining admixture according to 705.10.

6.5 Provide epoxy coated reinforcement according to 709.00, Grade 60 (Grade 420), or 709.14. In lieu of epoxy coated reinforcement, an approved corrosion inhibiting admixture may be added to the concrete at the approved dosage; and provide reinforcement according to 709.01, 709.03 or 709.05; Grade 60 (Grade 420) or 709.08, 709.10, 709.11 or 709.12. Provide epoxy or galvanized coated connections when connecting a precast structural unit into a cast-in-place structural component or between segments of adjacent precast structural units either manufactured as separate units or across construction joints when manufactured as one unit. Provide epoxy coated reinforcement according to 709.00 or 709.14, when these connections are designed using reinforcing steel. Provide galvanized coatings according to 711.02, when these connections are designed using connection plates, hardware or concrete inserts.

7.1 Design according to *AASHTO LRFD Bridge Design Specifications*, Section 12.14. Include a future wearing surface loading of 60 psf.

7.2 Ensure that the concrete cover dimension over reinforcement is a minimum of 2 inches (50 mm) in the slab and in the exterior of the leg. Ensure that

the interior of the leg reinforcement cover tapers from 1 inch (25 mm) at the bottom of the leg to 2 inches (50 mm) at the bottom of the haunch.

Ensure that the ends of longitudinal reinforcement have a minimum cover of 1/2 inch (13 mm), and spacers used to position the reinforcement are plastic or epoxy coated steel regardless of whether a corrosion inhibiting admixture is used.

8 Ensure that the top slab is produced with a keyway joint. The keyway provides a void volume equivalent to that of 12 inches (300 mm) prestressed beam as per Standard Construction Drawing PSBD-2-07. Ensure that the joint in the leg sections is designed to produce a shear key or inter-locking joint. Ensure that non-adjoining outside legs are flat. Sandblast the joint surfaces to the satisfaction of the Department, or a 2000 pounds per square inch (14 MPa) water blast no more than 14 days prior to shipping. Ensure that the culvert is designed such that the sections when laid together will make a continuous line with a smooth interior free of appreciable irregularities, all compatible with the permissible variations of Section 11.

9 Application of membrane waterproofing at any location other than the final location shown on the plans is prohibited.

9.1 Ensure that the aggregate, cement, and water are manufactured in conformance with 499.06 and 499.07.

Ensure that the temperature requirements of 511.08 and 511.15 are met.

Ensure that the proportion of cementitious and carbonate micro-fines is not less than 564 pounds per cubic yard (335 kg/m^3) of concrete.

If used, add the corrosion inhibitor as an aqueous solution. Consider the water in the solution as mixing water for the purpose of determining the w/c ratio of concrete.

9.2 Cure the three-sided sections in the forms for the length of time required to obtain the specified minimum design handling strength as defined in the shop drawings. Test a cylinder to check each section's design handling strength. Repeat this test as often as needed. Only one cylinder passing will ensure that the design handling strength has been met. If the shop drawing shows no design handling strengths, then the minimum handling strength is assumed to be 100 percent of the design strength. Ensure that the curing then continues either in or out of the forms until the specified minimum design strength is met.

9.2.1 Steam curing is an accelerated cure by low pressure steam or radiant heat within a suitable insulated enclosure to contain the live steam or heat. The initial application of the steam or heat is from two to four hours after the final placement of concrete to allow the initial set to take place. If retarders are used, increase the waiting period to 4 to 6 hours. As an alternative, determine the actual time of initial set according to ASTM C 403. Do not start curing until the actual time to initial set has elapsed.

During the waiting period, ensure that the temperature within the curing enclosure is not less than 50 °F (10 °C).

During the initial application of live steam or radiant heat, ensure that the ambient temperature within the curing enclosure increases at an average rate not exceeding 40 °F (22 °C) per hour until the curing temperature is reached.

Ensure that the maximum curing temperature does not exceed 150 °F (65 °C). Hold the design temperature until the concrete has reached the desired design strength. Do not direct the application of live steam on the concrete forms so as to cause localized high temperatures.

9.2.2 Provide water curing according to 511.15 and 511.17, Method A.

9.2.3 Provide membrane curing according to 511.16, Method B.

9.3 Ensure that all forms are in place until the design handling strength is met.

9.4 Holes for handling or setting are not permitted. Do not move members before the design handling strength of the concrete is reached, or shipped before the design strength of the concrete is reached. Ensure that the manufacturers have equipment necessary to handle and transport the pieces without damaging them.

10 Ensure that the hardened concrete contains a minimum of 4 percent entrained air.

10.2.1 Keep the cylinders and matching culvert section together to guarantee the cylinders are matched with the corresponding culvert section; or, upon agreement by the Department, keep the cylinders at a location that will provide the same environment as the culvert sections.

10.2.2 For each section of the culvert, produce and mark at least four cylinders so that they are identifiable with the matching culvert section.

10.2.3 Conform to Supplement 1073 for acceptance.

10.2.3.1 Ensure that cylinder strengths conform to Supplement 1073.

10.4 Plug the core holes by using a concrete that is the same as that used in the section and cured in according to Section 9.2, or by a non-shrink grout that exceeds the concrete design strength.

11 The design in the plan reflects the external top slab elevation of the structure. If the structure supplied has a deck thicker than the plan design, eliminate the difference between the design top slab elevation and the supplied top slab elevation by a reducing the leg length. The Department may approve alternate methods to eliminate the difference between the design top slab elevation and the supplied top slab elevation. The Department will not approve a change in the top slab elevation from that shown on the plans.

The clear span shown is the minimum for the structure. The manufacturer may provide a clear span greater than that shown. Base the exact footer locations for both the elevation and offset on the manufacturer's shop drawings. Ensure that these footer locations are such that the centerline of the leg at the bottom of the haunch matches the centerline of the footer.

All changes to the project resulting from the manufacturer's dimensional changes in the structure are at no charge to the Department.

Ensure that the sections are free of fractures spalls and chips. Ensure that all surfaces have a smooth and regular finish being defined as a 1/4-inch variation within 4 feet (6 mm variation within 1.2 m).

11.1 Ensure that the slab and walls are perpendicular with a diagonal difference of not more than 0.5 percent.

Ensure that the length of each section is within 1/2 inch (13 mm) of the design length. Consider the length is the average of the length measured at each side and at the middle of the three-sided section.

11.4 Ensure that the maximum variation in the position of the reinforcement is 3/8 inch (9 mm), except that the cover over the reinforcement for the external surface of the top slab is not less than 2 inches (50 mm). The above tolerances or cover requirements do not apply to mating surfaces at the joint.

11.5 Resubmit any change in reinforcement from the shop drawings for approval.

12 Make repairs according to the Department's requirements. The Department will not make additional payments for culvert repairs. Repairs are acceptable if, in the opinion of the Department, the repairs are sound, properly finished, and cured.

13 Perform inspection at the project site.

Furnish precast concrete components from suppliers certified according to Supplement 1073.

14 Form seams and slight surface irregularities that are expected from a wood panel forming system will not be cause for rejection. In addition, hairline cracks less than 0.01 inch (0.25 mm) are not cause for rejection.

15.1 Ensure that the location of the product marking is on the interior of the three-sided section 1 foot (300 mm) below the leg haunch.

Add the product marking upon removal of the forms.

The manufacturer may be required to repeat the product markings before the project is final.

706.052 Precast Reinforced Concrete Arch Sections. Provide precast reinforced concrete arch sections according to ASTM C 1504, with the following modifications:

This item shall consist of manufacturing precast reinforced concrete arch sections for culverts.

Ensure that manufacturers of precast concrete members are certified according to Supplement 1073.

5 Ensure the manufacturer submits design calculations, a structural load rating and shop drawings according to 611.04. Ensure the shop drawings include the following:

1. Load rate the structure according to the requirements of section 900 of the Department's Bridge Design Manual.
2. All material specifications.
3. All plan view.
4. All elevation view.
5. All headwall and wingwall attachment requirements.
6. All dimensions.
7. All maintenance of traffic phases.
8. All section sizes.
9. All design handling strength.

The manufacturer may modify an approved shop drawing and resubmit for approval to the Department.

Ensure that the shop drawings also include the following special information as required:

1. For top mounted guardrail, the guardrail plate and bolt locations are shown in the plan view. Holes shall be a minimum of 6 inches (150 mm) from a joint.
2. The corrosion inhibitor being used, if any, and dosage rate. Dosage rate will be approved by the Laboratory.

6.2.1 Provide cement according to 701, except 701.07.

6.2.2 Provide fly ash according to 701.13.

6.2.4.9 Provide carbonate micro-fines according to 705.27 and Table 499.03-2.

6.3 Provide aggregates conforming to the quality requirements of 703.02.

6.4 Use chemical admixtures according to 705.12. Use a corrosion inhibitor unless epoxy coated reinforcing steel is used. An approved list of corrosion inhibiting admixtures is on file at the Laboratory. Manufacturers should recognize that the corrosion inhibitors and admixtures may have an effect on strength, entrained air content, workability, etc. of their concrete mixes. The manufacturers choice of one of these corrosion inhibitors does not alleviate meeting all design requirements of this structure.

6.4.1 Provide air-entraining admixture according to 705.10.

6.5 Provide epoxy coated reinforcement according to 709.00, Grade 60 (Grade 420), or 709.14. In lieu of epoxy coated reinforcement, an approved corrosion inhibiting admixture may be added to the concrete at the approved dosage; and provide reinforcement according to 709.01, 709.03 or 709.05; Grade 60 (Grade 420) or 709.08, 709.10, 709.11 or 709.12. Provide epoxy or galvanized coated connections when connecting a precast structural unit into a cast-in-place structural component or between segments of adjacent precast structural units either manufactured as separate units or across construction joints when manufactured as one unit. Provide epoxy coated reinforcement according to 709.00 or 709.14, when these connections are designed using reinforcing steel. Provide galvanized coatings

according to 711.02, when these connections are designed using connection plates, hardware or concrete inserts.

7.1 Design according to *AASHTO LRFD Bridge Design Specifications*, Section 12.14. Include a future wearing surface loading of 60 psf.

7.2 Ensure that the concrete cover dimension over the outside circumferential reinforcement is a minimum of 2 inches (50 mm). Ensure that the concrete cover dimension over the inside circumferential reinforcement is a minimum of 1 1/2 inches (38 mm). The clear distance of the end circumferential wires shall not be less than 1 inch (25 mm) nor more than 2 inches (50 mm) from the ends of the sections. Reinforcement shall be assembled utilizing single or multiple layers of welded wire fabric (three-layer maximum), or utilizing a single layer of deformed billet-steel bars. The welded wire fabric shall be composed of circumferential and longitudinal wires and shall contain sufficient longitudinal wires extending through the section to maintain the shape and position of reinforcement. Longitudinal distribution reinforcement may be welded wire fabric or deformed billet-steel bars. The ends of the longitudinal distribution reinforcement shall be not more than 3 inches (75 mm) from the ends of the sections.

The outside and inside circumferential reinforcing steel for the corners of the culvert shall be bent to such an angle that it is approximately equal to the configuration of the culverts outside corner.

7.3 Tension splices in the circumferential reinforcement shall not be made. For splices other than tension splices, the overlap shall be a minimum of 12 inches (300 mm) for welded wire fabric or deformed billet steel bars. The spacing center-to-center of the circumferential wires in a wire fabric sheet shall be not less than 2 inches (50 mm) or more than 4 inches (100 mm). For the wire fabric, the spacing center-to-center of the longitudinal wire shall not be more than 8 inches (200 mm). The spacing center-to-center of the longitudinal distribution steel for either line of reinforcing in the top slab shall be not more than 16 inches (410 mm).

8.1 Ensure the sections are produced with butt ends. The ends of the sections shall be such that when the sections are laid together they will make a continuous line of sections with a smooth interior free of appreciable irregularities, all compatible with the permissible variations in these Specifications. Provide a chamfer on the outside surface at the sections joint to form a void for a 7/8 × 1 3/8-inch (24 × 34 mm) flexible plastic gasket 706.14.

9 Application of membrane waterproofing on the arch section at any location other than the final location shown on the plans is prohibited.

9.1 Ensure that the aggregate, cement, and water are manufactured according to 499.06 and 499.07.

Ensure that the temperature requirements of 511.08 and 511.15 are met.

Ensure that the proportion of cementitious and carbonate micrio-fines is not less than 564 pounds per cubic yard (335 kg/m^3) of concrete.

If used, add the corrosion inhibitor as an aqueous solution. Consider the water in the solution as mixing water for the purpose of determining the water-cement ratio of concrete.

9.2 Cure the arch sections in the forms for the length of time required to obtain the specified minimum design handling strength as defined in the shop drawings. Test a cylinder to check each section's design handling strength. Repeat this test as often as needed. Only one cylinder passing will ensure that the design handling strength has been met. If the shop drawing shows no design handling strengths, then the minimum handling strength is assumed to be 100 percent of the design strength. Ensure that the curing then continues either in or out of the forms until the specified minimum design strength is met.

9.2.1 Steam curing is an accelerated cure by low pressure steam or radiant heat within a suitable insulated enclosure to contain the live steam or heat. The initial application of the steam or heat is from 2 to 4 hours after the final placement of concrete to allow the initial set to take place. If retarders are used, increase the waiting period to 4 to 6 hours. As an alternative, determine the actual time of initial set according to ASTM C 403. Do not start curing until the actual time to initial set has elapsed.

During the waiting period, ensure that the temperature within the curing enclosure is not less than 50 °F (10 °C).

During the initial application of live steam or radiant heat, ensure that the ambient temperature within the curing enclosure increases at an average rate not exceeding 40 °F (22 °C) per hour until the curing temperature is reached.

Ensure that the maximum curing temperature does not exceed 150 °F (65 °C). Hold the design temperature until the concrete has reached the desired design strength. Do not direct the application of live steam on the concrete forms so as to cause localized high temperatures.

9.2.2 Provide water curing according to 511.15 and 511.17, Method A.

9.3 Ensure that all forms are in place until the design handling strength is met.

Holes for handling or setting are not permitted. Do not move members before the design handling strength of the concrete is reached, or shipped before the design strength of the concrete is reached. Ensure that the manufacturers have equipment necessary to handle and transport the pieces without damaging them.

10 Ensure that the hardened concrete contains a minimum of 4 percent entrained air.

10.2.1 Keep the cylinders and matching culvert section together to guarantee the cylinders are matched with the corresponding culvert section; or, upon agreement by the Department, keep the cylinders at a location that will provide the same environment as the culvert sections.

10.2.2 For each section of the culvert, produce and mark at least four cylinders so that they are identifiable with the matching culvert section.

10.2.3 Conform to Supplement 1073 for acceptance.

10.2.3.1 Ensure that cylinder strengths conform to Supplement 1073.

10.4 Plug the core holes by using a concrete that is the same as that used in the section and cured according to Section 9.2, or by a non-shrink grout that exceeds the concrete design strength.

11.0 The under-run in length of a section shall not be more than 1/2 inch (13 mm).

All changes to the project resulting from the manufacturer's dimensional changes in the structure are at no charge to the Department.

Ensure that the sections are free of fractures spalls and chips. Ensure that all surfaces have a smooth and regular finish being defined as a 1/4 inch variation within 4 feet (6 mm variation within 1.2 m).

11.1 The internal dimensions shall vary not more than 1 percent from the design dimensions or more than 38 mm (1 1/2 inches), whichever is less. The haunch dimensions shall vary not more than 19 mm (3/4 inch) from the design dimension.

11.4 Ensure that the maximum variation in the position of the reinforcement is 3/8 inch (9 mm), except that the cover over the reinforcement for the external surface of the top slab is not less than 2 inches (50 mm). The above tolerances or cover requirements do not apply to mating surfaces at the joint.

11.5 Resubmit any change in reinforcement from the shop drawings for approval.

12.0 Make repairs according to the Department's requirements. The Department will not make additional payments for culvert repairs. Repairs are acceptable if, in the opinion of the Department, the repairs are sound, properly finished, and cured.

13.0 Perform inspection at the project site.

Furnish precast concrete components from suppliers certified according to Supplement 1073.

14.0 Form seams and slight surface irregularities that are expected from a wood panel forming system will not be cause for rejection. In addition, hairline cracks less than 0.01 inch (0.25 mm) will not be cause for rejection.

15.1 Ensure that the location of the product marking is on the interior of the arch section 1 foot (300 mm) below the leg haunch.

Add the product marking upon removal of the forms.

The manufacturer may be required to repeat the product markings before the project is final.

706.053 Precast Reinforced Concrete Round Sections. Provide precast reinforced concrete elliptical and circular arch sections according to ASTM C 1504, with the following modifications:

706.05

This item shall consist of manufacturing precast reinforced concrete elliptical and circular arch sections for culverts.

Ensure that manufacturers of precast concrete members are certified according to Supplement 1073.

5. Ensure the manufacturer submits design calculations, a structural load rating and shop drawings according to 611.04. Ensure the shop drawings include the following:

1. Load rate the structure according to the requirements of section 900 of the Department's Bridge Design Manual.
2. All material specifications.
3. Plan view.
4. Elevation views.
5. Headwall and wingwall attachment requirements.
6. Dimensions.
7. All maintenance of traffic phases.
8. Section sizes.
9. Design handling strength.

The manufacturer may modify an approved shop drawing and resubmit for approval to the Department.

Ensure that the shop drawings also include the following special information as required:

1. For top mounted guardrail, the guardrail plate and bolt locations are shown in the plan view. Holes shall be a minimum of 6 inches (150 mm) from a joint.
2. The corrosion inhibitor being used, if any, and dosage rate. Dosage rate will be approved by the Laboratory.

6.2.1 In addition, provide cement according to 701, except 701.07.

6.2.2 Provide fly ash conforming to 701.13.

6.2.4.9 Provide carbonate micro-fines according to 705.27 and Table 499.03-2.

6.3 Provide aggregates conforming to the quality requirements of 703.02.

6.4 Use chemical admixtures conforming to 705.12. Use a corrosion inhibitor unless epoxy coated reinforcing steel is used. An approved list of corrosion inhibiting admixtures is on file at the Laboratory. Manufacturers should recognize that the corrosion inhibitors and admixtures may have an effect on strength, entrained air content, workability, etc. of their concrete mixes. The manufacturer's choice of one of these corrosion inhibitors does not alleviate meeting all design requirements of this structure.

6.4.1 Provide air-entraining admixture conforming to 705.10.

6.5 Provide epoxy coated reinforcement according to 709.00, Grade 60 (Grade 420), or 709.14. In lieu of epoxy coated reinforcement, an approved corrosion inhibiting admixture may be added to the concrete at the approved dosage;

and provide reinforcement according to 709.01, 709.03 or 709.05; Grade 60 (Grade 420) or 709.08, 709.10, 709.11 or 709.12. Provide epoxy or galvanized coated connections when connecting a precast structural unit into a cast-in-place structural component or between segments of adjacent precast structural units either manufactured as separate units or across construction joints when manufactured as one unit. Provide epoxy coated reinforcement according to 709.00 or 709.14, when these connections are designed using reinforcing steel. Provide galvanized coatings according to 711.02, when these connections are designed using connection plates, hardware or concrete inserts.

7.1 Modify the first sentence as follows: Design according to *AASHTO LRFD Bridge Design Specifications*, Section 12.14. Include a future wearing surface loading of 60 psf.

7.2 Ensure that the concrete cover dimension over the outside circumferential reinforcement is a minimum of 2 inches (50 mm). Ensure that the concrete cover dimension over the inside circumferential reinforcement is a minimum of 1 1/2 inches (38 mm). The clear distance of the end circumferential wires shall not be less than 1 inch (25 mm) nor more than 2 inches (50 mm) from the ends of the sections. Reinforcement shall be assembled utilizing single or multiple layers of welded wire fabric (three-layer maximum), or utilizing a single layer of deformed billet-steel bars. The welded wire fabric shall be composed of circumferential and longitudinal wires and shall contain sufficient longitudinal wires extending through the section to maintain the shape and position of reinforcement. Longitudinal distribution reinforcement may be welded wire fabric or deformed billet-steel bars. The ends of the longitudinal distribution reinforcement shall be not more than 3 inches (75 mm) from the ends of the sections.

Form the outside and inside circumferential reinforcing steel for the arch such that it is approximately equal to the configuration of the arch shape.

7.3 In addition, tension splices in the circumferential reinforcement shall not be made. For splices other than tension splices, the overlap shall be a minimum of 12 inches (300 mm) for welded wire fabric or deformed billet steel bars. The spacing center-to-center of the circumferential wires in a wire fabric sheet shall be not less than 2 inches (50 mm) or more than 4 inches (100 mm). For the wire fabric, the spacing center-to-center of the longitudinal wire shall not be more than 8 inches (200 mm). The spacing center-to-center of the longitudinal distribution steel for either line of reinforcing in the top slab shall be not more than 16 inches (410 mm).

8.1 Ensure the sections are produced with butt ends. The ends of the sections shall be such that when the sections are laid together they will make a continuous line of sections with a smooth interior free of appreciable irregularities, all compatible with the permissible variations in these Specifications and section 11 of ASTM C 1504. Provide a 3/4 × 3/4 inch (19 × 19 mm) minimum chamfer on the inside and outside surface at the sections joint.

Ensure that the design of the arch in its final constructed location is structurally continuous throughout the arch unit providing for flexural, compressive and shear force transfers. For arches that gain structural continuity by a cast in place closure at the project site, provide concrete with the same compressive strength as the

precast arch. In addition, the cast in place closure shall provide continuity in the transverse direction (90 degrees to the span) along the lay length of the arches.

9.1 Ensure that the aggregate, cement, and water are manufactured according to 499.06 and 499.07.

Ensure that the temperature requirements of 511.08 and 511.15 are met.

Ensure that the proportion of cementitious and carbonate micro-fines is not less than 564 pounds per cubic yard (335 kg/m³) of concrete.

If used, add the corrosion inhibitor as an aqueous solution. Consider the water in the solution as mixing water for the purpose of determining the water-cement ratio of concrete.

9.2 Cure the arch sections in the forms for the length of time required to obtain the specified minimum design handling strength as defined in the shop drawings. Test a cylinder to check each section's design handling strength. Repeat this test as often as needed. Only one cylinder passing will ensure that the design handling strength has been met. If the shop drawing shows no design handling strengths, then the minimum handling strength is assumed to be 100 percent of the design strength. Ensure that the curing then continues either in or out of the forms until the specified minimum design strength is met.

9.2.1 Steam curing is an accelerated cure by low pressure steam or radiant heat within a suitable insulated enclosure to contain the live steam or heat. The initial application of the steam or heat is from 2 to 4 hours after the final placement of concrete to allow the initial set to take place. If retarders are used, increase the waiting period to 4 to 6 hours. As an alternative, determine the actual time of initial set according to ASTM C 403. Do not start curing until the actual time to initial set has elapsed.

During the waiting period, ensure that the temperature within the curing enclosure is not less than 50 °F (10 °C).

During the initial application of live steam or radiant heat, ensure that the ambient temperature within the curing enclosure increases at an average rate not exceeding 40 °F (22 °C) per hour until the curing temperature is reached.

Ensure that the maximum curing temperature does not exceed 150 °F (65 °C). Hold the design temperature until the concrete has reached the desired design strength. Do not direct the application of live steam on the concrete forms so as to cause localized high temperatures.

9.2.2 Provide water curing according to 511.15 and 511.17, Method A.

9.3 Ensure that all forms are in place until the design handling strength is met.

Holes for handling or setting are not permitted. Do not move members before the design handling strength of the concrete is reached, or shipped before the design strength of the concrete is reached. Ensure that the manufacturers have equipment necessary to handle and transport the pieces without damaging them.

10 Ensure that the hardened concrete contains a minimum of 4 percent entrained air.

10.1 Cores drilled from the section are not permitted.

10.2.1 Keep the cylinders and matching arch section together to guarantee the cylinders are matched with the corresponding culvert section; or, upon agreement by the Department, keep the cylinders at a location that will provide the same environment as the arch sections.

10.2.2 For each section of the arch structure, produce and mark at least four cylinders so that they are identifiable with the matching arch section.

10.2.3 Conform to Supplement 1073 for acceptance.

10.2.3.1 Ensure that cylinder strengths conform to Supplement 1073.

11.0 The under-run in length of a section shall not be more than 1/2 inch (13 mm).

All changes to the project resulting from the manufacturer's dimensional changes in the structure are at no charge to the Department.

Ensure that the sections are free of fractures spalls and chips. Ensure that all surfaces have a smooth and regular finish being defined as a 1/4 inch variation within 4 feet (6 mm variation within 1.2 m).

11.1 The internal dimensions shall vary not more than 1 percent from the design dimensions or more than 1 1/2 inches (38 mm), whichever is less. The haunch dimensions shall vary not more than 3/4 inch (19 mm) from the design dimension.

11.4 Ensure that the maximum variation in the position of the reinforcement is 3/8 inch (9 mm), except that the cover over the reinforcement for the external surface of the top is not less than 2 inches (50 mm). The above tolerances or cover requirements do not apply to mating surfaces at the joint.

11.5 Resubmit any change in reinforcement from the shop drawings for approval.

11.6 All interior and exterior arch surfaces shall have a smooth steel form finish.

12.0 Make repairs according to the Department's requirements. The Department will not make additional payments for arch repairs. Repairs are acceptable if, in the opinion of the Department, the repairs are sound, properly finished, and cured.

13.0 The Department may perform inspection at the plant conforming to Supplement 1073 but final inspection and acceptance will be at the project site.

Furnish precast concrete components from suppliers certified according to Supplement 1073.

14.0 Form seams and slight surface irregularities that are expected from a steel panel forming system will not be cause for rejection. In addition, hairline cracks less than 0.01 inch (0.25 mm) will not be cause for rejection.

15.1 Ensure that the location of the product marking is on the interior of the arch section 4 feet (1.2 m) above the base of the arch. Measure the 4 feet (1.2 m) from the base of the arch along the circumference of the interior surface.

Add the product marking upon removal of the forms.

The manufacturer may be required to repeat the product markings before the project is final.

706.06 Perforated Concrete Pipe. Provide perforated concrete pipe according to ASTM C 444 (ASTM C 444M), and 706.01 or 706.02.

Ensure manufacturers providing materials are certified according to Supplement 1074.

706.07 Concrete Drain Tile. Provide extra-quality concrete drain tile according to ASTM C 412 (ASTM C 412M), with the following modifications:

Ensure manufacturers providing materials are certified according to Supplement 1074.

4.0 This specification covers extra-quality concrete drain tile only.

5.1(3) Does not apply.

6.2.1 Provide cement according to 701, except 701.07.

6.2.2 Provide fly ash according to 701.13

6.3 Provide aggregate conforming to the quality requirements of 703.02.

8.1 Perform inspection at the project site. Obtain random samples from material delivered to the project site or at other locations designated by the Laboratory. Ensure manufacturers providing materials are certified according to Supplement 1074.

Testing. Ensure that the manufacturer furnishes all facilities and personnel to carry out the tests.

706.08 Vitrified Clay Pipe. Provide vitrified clay pipe according to ASTM C 700, with the following modifications:

Furnish materials according to the Department's QPL.

14.0 Perform all tests except hydrostatic according to ASTM C 301.

15.0 Perform inspection at the project site. Obtain random samples from material delivered to the project site or at other locations designated by the Laboratory.

706.09 Clay Drain Tile. Provide extra-quality clay drain tile according to ASTM C 4, with the following modifications:

6.1 Perform inspection at the project site. Obtain random samples from material delivered to the project site or at other locations designated by the Laboratory.

11, 12, and 13 Ensure that the manufacturer furnishes all facilities and personnel to carry out the tests.

Furnish materials according to the Department's QPL.

706.10 Bituminous Pipe Joint Filler. Provide cold applied, mineral filled, joint sealing compound for joints of bell and spigot, or tongue and groove sewer; or drain pipe conforming to the following:

A. Composition. Provide a steam-refined petroleum asphalt or a refined coal tar, dissolved in a suitable solvent, and containing an appropriate stiffener.

B. General Requirement. Provide a bituminous plastic cement that has a smooth, uniform mixture, not thickened or livered, and that shows a separation easily overcome by stirring. Ensure that the material is of such consistency and properties that it is readily applied with a trowel, a putty knife, or with a caulking gun without pulling or drawing. Provide a material that when applied to metal, concrete, or vitrified clay surfaces, exhibits good adhesive and cohesive properties and has only slight shrinkage after curing. Provide a material that is not damaged by exposure to below freezing temperatures.

C. Detail Requirements. Provide materials conforming to the following requirements:

1.	When applied in a layer 1/16 to 1/8-inch (1.6 to 3.2 mm) thick on a tinned metal panel and cured at room temperature for 24 hours, the bituminous plastic cement shall set to a tough, plastic coating, free from blisters.		
		Minimum	Maximum
2.	Grease Cone Penetration (unworked, 150 grams, 25 °C, 5 sec, ASTM D 217, mm/10	175	250
3.	Weight, kg/L	1.17	--
4.	Non-volatile, 10 g, 105 to 110 °C, 24 hrs, %	75	--
5.	Ash, by ignition, %	25	45

Furnish materials according to the Department's QPL.

706.11 Resilient and Flexible Gasket Joints. Provide resilient and flexible gasket joints for concrete pipe according to ASTM C 443 (ASTM C 443M).

Furnish materials according to the Department's QPL.

706.12 Resilient and Flexible Joints. Provide resilient and flexible joints for vitrified clay pipe according to ASTM C 425.

Furnish materials according to the Department's QPL.

706.13 Precast Reinforced Concrete Manhole Riser Sections, Flat Slab Tops, Catch Basins and Inlet Tops, and Portable Barriers. Provide precast reinforced concrete manhole riser sections, flat slab tops, catch basins and inlet tops, and portable barriers according to ASTM C 478 (ASTM C 478M), with the following modifications:

1.1 Provide precast catch basin tops where permitted by the plans.

4.1.2.1 Provide cement according to 701, except 701.07.

4.1.2.2 Provide fly ash according to 701.13.

4.1.4 Provide aggregate conforming to the quality requirements of 703.02.

4.1.6 Provide steel according to 709.01, 709.08, 709.10, or 709.12. Provide epoxy coated steel according to 709.00 for the manhole flat slab tops, catch basin tops and inlet tops only.

7.0 Ensure that no more than two holes are cast, drilled, or otherwise neatly made in the shell of each piece of each riser section for the purpose of handling or laying. Taper the holes unless drilled, and before backfilling fill the tapered holes with portland cement mortar, precast concrete plugs secured with portland cement mortar, or a device on the Department's Approved List specifically designed for filling the hole. Fill drilled holes with portland cement mortar.

8.2.2 Absorption test does not apply

10.0 Perform inspection at the project site.

11.0 In addition, mark the plant location on each manhole top or barrier section.

Ensure manufacturers providing materials are certified according to Supplement 1073

Ensure structures that have a span of 10 feet or greater and are located under the traveled way, including the treated shoulder width, are designed in accordance with the AASHTO LRFD Bridge Design Specifications. Have competent individuals prepare and check the shop drawings. Provide a cover sheet containing the preparer(s) and checker(s): First Name, Last Name, Initials and Content Responsibility. Preparer(s) and checker(s) shall initial each sheet for their content responsibility. The preparer(s) and checker(s) shall not be the same individual. Have an Ohio Registered Engineer review, approve, sign, seal and date the shop drawing cover sheet or submittal letter according to ORC 4733 and OAC 4733-35.

706.14 Preformed Flexible Joint Sealant. Provide preformed flexible joint sealant for concrete conduit according to ASTM C 990.

Furnish materials according to the Department's QPL.

706.15 Precast Reinforced Concrete Outlets. Provide precast reinforced concrete outlets composed of cement conforming to 701, except 701.07. Provide aggregate conforming to the quality requirements of 703.02. Provide epoxy coated steel reinforcement conforming to 709.00. Do not provide holes for handling or laying. Ensure that the outlet hole are the same size as the outlet pipe. Perform inspection at the project site.

Ensure manufacturers providing materials are certified according to Supplement 1073.

707 STEEL, ALUMINUM, AND PLASTIC PIPE

707.00 Acceptance. Corrugated metal pipe conforming to 707.01, 707.02, 707.03, 707.04, 707.05, 707.07, 707.11, 707.12, 707.13, 707.14, 707.15, 707.21,

707.22, 707.23, 707.24, and 707.25 may be accepted for shipment to and immediate use in construction projects when provided from suppliers certified according to Supplement 1019.

707.01 Metallic Coated Corrugated Steel Conduits and Underdrains. Provide conduits and underdrains having a corrugation depth of 1/2 or 1/4 inch (13 or 6.5 mm) and according to AASHTO M 36/M 36M, with the following modifications:

7.7.1 Helical corrugated pipe, 12-inch (300 mm) diameter and larger, shall have at least two annular corrugations at each end of each pipe length.

8.1.2 Ensure that the minimum wall thickness (coated) of steel pipe and pipe-arches is as follows:

Pipe			Pipe-Arch	
Diameter (inch)	**Wall Thickness (inch)**		**Size (inch)**	**Wall Thickness (inch)**
6	0.052			
8	0.064			
10	0.064			
12	0.064			
15	0.064		17 × 13	0.064
18	0.064		21 × 15	0.064
21	0.064		24 × 18	0.064
24	0.064		28 × 20	0.064
27	0.064			
30	0.064		35 × 24	0.064
33	0.064			
36	0.064		42 × 29	0.064
42	0.064		49 × 33	0.079
48	0.064		57 × 38	0.109
54	0.079		64 × 43	0.109
60	0.109		71 × 47	0.138
66	0.138		77 × 52	0.168
72	0.138		83 × 57	0.168
78	0.168			
84	0.168			

Pipe		Pipe-Arch	
Diameter	Wall Thickness	Size	Wall Thickness
(mm)	(mm)	(mm)	(mm)
150	1.32		
200	1.63		
250	1.63		
300	1.63		
375	1.63	430 × 340	1.63
450	1.63	530 × 380	1.63
525	1.63	610 × 460	1.63
600	1.63	710 × 510	1.63
675	1.63		
750	1.63	885 × 610	1.63
825	1.63		
900	1.63	1060 × 740	1.63
1050	1.63	1240 × 840	2.01
1200	1.63	1440 × 970	2.77
1350	2.01	1620 × 1100	2.77
1500	2.77	1800 × 1200	3.51
1650	3.51	1950 × 1320	3.51
1800	3.51	2100 × 1450	4.27
1950	4.27		
2100	4.27		

Ensure that the minus tolerance conforms to AASHTO M 218, M 274, or M 289.

TABLE 707.01-1 PIPE REQUIREMENTS

Nominal Inside Diameter		Corrugation Depth Nominal		Minimum Width of Lap	
(inch)	(mm)	(inch)	(mm)	(inch)	(mm)
27	675	1/2	13	2	50
33	825	1/2	13	2	50

8.3.2.1 Ensure that the minimum number of longitudinal rows of perforations is four.

9.1 Coupling bands shall have annular corrugations.

9.2 Ensure that coupling bands are not more than two nominal sheet thicknesses thinner than the thickness of the pipe to be connected. For pipes 48-inch (1200 mm) diameter and smaller, ensure that the coupling band is not thinner than the 0.052-inch (1.32 mm) nominal sheet thickness. For pipes 54-inch (1350 mm) diameter through 84-inch (2100 mm) diameter, ensure that the coupling band is not thinner than the 0.064-inch (1.63 mm) nominal sheet thickness. For pipe diameters over 36 inches (900 mm), provide coupling bands that have at least one annular corrugation that indexes into the inboard corrugation of each pipe section joined.

707.02 Metallic Coated Corrugated Steel Conduits [1-inch (25 mm) Corrugations]. Provide conduits according to AASHTO M 36/M 36M, with the following modifications:

7.7.1 Helical corrugated pipe shall have at least two annual corrugations at each end of each pipe length.

8.1.2 Ensure that the minimum wall thickness (coated) of steel pipe and pipe-arches is as follows:

Pipe			Pipe-Arch	
Diameter	**Wall Thickness**		**Size**	**Wall Thickness**
(inch)	**(inch)**		**(inch)**	**(inch)**
36	0.064		40 × 31	0.109
42	0.064		46 × 36	0.109
48	0.064		53 × 41	0.109
54	0.079		60 × 46	0.109
60	0.079		66 × 51	0.109
66	0.109		73 × 55	0.109
72	0.109		81 × 59	0.109
78	0.109		87 × 63	0.109
84	0.109		95 × 67	0.109
90	0.109		103 × 71	0.109
96	0.109		112 × 75	0.109
102	0.109		117 × 79	0.109
108	0.109		128 × 83	0.138
114	0.109		137 × 87	0.138
120	0.109		142 × 91	0.168

Pipe			Pipe-Arch	
Diameter	**Wall Thickness**		**Size**	**Wall Thickness**
(mm)	**(mm)**		**(mm)**	**(mm)**
900	1.63		1010 × 790	2.77
1050	1.63		1160 × 920	2.77
1200	1.63		1340 × 1050	2.77
1350	2.01		1520 × 1170	2.77
1500	2.01		1670 × 1300	2.77
1650	2.01		1850 × 1400	2.77
1800	2.77		2050 × 1500	2.77
1950	2.77		2200 × 1620	2.77
2100	2.77		2400 × 1720	2.77
2250	2.77		2600 × 1820	2.77
2400	2.77		2840 × 1920	2.77
2550	2.77		2970 × 2020	2.77
2700	2.77		3240 × 2120	3.51
2850	2.77		3470 × 2220	3.51
3000	2.77		3600 × 2320	4.27

Ensure that the minus tolerance conforms to AASHTO M 218, M 274, or M 289.

9.1 Provide coupling bands with a minimum wall thickness (coated) of 0.064 inch (1.63 mm) and that have at least one annular corrugation that indexes into the inboard corrugations of each pipe section joined.

707.03 Structural Plate Corrugated Steel Structures. Provide structural plate pipe, pipe arch, and arch structures according to AASHTO M 167 (AASHTO M 167M), with the following modification:

5.4 Assembly bolts may be galvanized by an electrolytic process.

707.04 Precoated, Galvanized Steel Culverts. Provide conduits and coupling bands according to AASHTO M 245/M 245M, as modified by 707.01 and 707.02. Ensure that the precoated, galvanized steel sheets conform to AASHTO M 246/M 246M, Type B. Ensure that the polymeric coating is 10 mils (250 μm) on the interior and 10 mils (250 μm) on the exterior.

707.05 Bituminous Coated Corrugated Steel Pipe and Pipe Arches with Paved Invert [1/2-inch (13 mm) Corrugations]. Provide conduits and coupling bands according to 707.01 and to AASHTO M 190. Provide either Type B half bituminous coated pipe, or pipe arches with paved invert or Type C fully coated pipe, or pipe arches with paved invert.

707.07 Bituminous Coated Corrugated Steel Pipe and Pipe Arches with Paved Invert [1-inch (25 mm) Corrugations]. Provide conduits and coupling bands according to 707.02 and to AASHTO M 190. Provide either Type B half bituminous coated pipe, or pipe arches with paved invert or Type C fully coated pipe, or pipe arches with paved invert.

707.10 Square and Rectangular Steel Tubing. Provide square and rectangular steel tubing according to ASTM A 501 or ASTM A 500, Grade B, with the following modifications:

Galvanize the tubing according to 711.02.

Test the tubular steel from all heat numbers supplied for toughness according to ASTM E 436, except as modified herein. Take and test tubing test samples before delivery of the railing. Ensure that the taking of the test samples is witnessed and the testing is performed by an independent test laboratory. Submit certified test data for review and approval as specified in 501.06.

Perform testing on test specimens obtained from galvanized tubing with the same heat number as that being used. Conduct the testing at a temperature of 0 °F (-18 °C) on 2 × 9-inch (50 × 225 mm) specimens supported to provide a 7-inch (180 mm) clear span. Do not remove the galvanizing from the specimens. Cut three 2 × 9-inch (50 × 225 mm) test specimens from each of the unwelded sides for a total of nine specimens. If all three unwelded sides are not large enough to remove 2 × 9-inch (50 × 225 mm) specimens, then remove nine specimens from any unwelded side.

Disregard the three specimens from the side with the lowest average shear area when calculating the final average shear area. If specimens were not removed from three unwelded sides, then disregard the three specimens with the lowest average shear area. Calculate the final average shear area using the six remaining specimens. If the average shear area falls below 50 percent, reject material from the heat represented by these tests. However, if the average shear area is 30 percent or greater, the Department will allow one retest at a sampling frequently three times that of the first test, and with no samples excluded in calculating the average. Reject materials not having a 50 percent average shear area upon retest.

Before galvanizing, the manufacturer of the tubing shall identify the product with the steel heat number (or with some number that is traceable to the heat number) and with the manufacturer's unique identification code to facilitate acceptance or rejection of the material. Ensure that the identification method is such that identification is on only one face of the section, and is repeated at intervals no greater than 4 feet (1.2 m), and does not extend into the curved surface of the tubing at the corners.

707.11 Polymer-Precoated Corrugated Steel Spiral Rib Conduits. Provide conduits that have a center-to-center rib spacing of 7 1/2 inches (190 mm). Provide conduits and fittings according to AASHTO M 36, Type IR, with the following modifications:

6.1 Fabricate pipe from polymer-precoated, on both sides, steel sheet according to AASHTO M 246.

7.2.2 The ribs shall conform to AASHTO M 196, Section 7.2.2.

7.7.1 Reroll the ends of the individual pipe sections to form at least two annular corrugations on each end. Paint the rerolled end with zinc rich paint.

8.1.2 Ensure that the minimum wall thickness (coated) of steel pipe is as follows:

Pipe

Diameter (inch)	Wall Thickness (inch)		Diameter (mm)	Wall Thickness (mm)
18	0.064		450	1.63
21	0.064		525	1.63
24	0.064		600	1.63
30	0.064		750	1.63
36	0.064		900	1.63
42	0.064		1050	1.63
48	0.064		1200	1.63
54	0.079		1350	2.01
60	0.079		1500	2.01
66	0.109		1650	2.77
72	0.109		1800	2.77
78	0.109		1950	2.77
84	0.138		2100	3.51
90	0.138		2250	3.51

9.1 Coupling bands shall have annular corrugations.

9.2 Coupling bands shall conform to 707.01.

9.3 A bell and spigot joint according to ASTM A 760 (A760M) may be used with the following modifications:

9.3.1 These joints may be used for conduits ranging in size from 18 (450mm) to 48 (1200mm) inches in diameter.

9.3.2 Ensure the bell and spigot has a soil tight joint by use of a shop applied gasket on the bell end and a field applied gasket on the spigot end.

9.3.3 Provide a minimum of 0.064 (1.63mm) inch nominal sheet thickness or not more than two (2) nominal sheet thickness thinner than the thickness of the pipe to be joined.

14.1 Ensure that the certification and sampling conform to 707.01.

707.12 Corrugated Steel Spiral Rib Conduits. Provide conduits that have a center-to-center rib spacing of 7 1/2 inches (190 mm). Provide conduits and fittings according to AASHTO M 36, Type IR, with the following modifications:

6.1 Fabricate pipe from aluminum coated sheet according to AASHTO M 274.

7.2.2 The ribs shall conform to AASHTO M 196, Section 7.2.2.

7.7.1 Reroll the ends of the individual pipe sections to form at least two annular corrugations on each end. Paint the rerolled end with zinc rich paint.

8.1.2 Ensure that the minimum wall thickness (coated) of steel pipe is as follows:

Pipe

Diameter (inch)	Wall Thickness (inch)		Diameter (mm)	Wall Thickness (mm)
18	0.064		450	1.63
21	0.064		525	1.63
24	0.064		600	1.63
30	0.064		750	1.63
36	0.064		900	1.63
42	0.064		1050	1.63
48	0.064		1200	1.63
54	0.079		1350	2.01
60	0.079		1500	2.01
66	0.109		1650	2.77
72	0.109		1800	2.77
78	0.109		1950	2.77
84	0.138		2100	3.51
90	0.138		2250	3.51

9.1 Coupling bands shall have annular corrugations.

9.2 Coupling bands shall conform to 707.01.

9.3 A bell and spigot joint according to ASTM A760 (A760M) may be used with the following modifications:

9.3.1 These joints may be used for conduits ranging in size from 18 (450mm) to 48 (1200mm) inches in diameter.

9.3.2 Ensure the bell and spigot has a soil tight joint by use of a shop applied gasket on the bell end and a field applied gasket on the spigot end.

9.3.3 Provide a minimum of 0.064 (1.63mm) inch nominal sheet thickness or not more than two (2) nominal sheet thickness thinner than the thickness of the pipe to be joined.

14.1 Ensure that the certification and sampling conforms to 707.01.

707.13 Bituminous Lined Corrugated Steel Pipe [1/2-inch (13 mm) Corrugations]. Provide pipe according to 707.01 and AASHTO M 190, Type D.

707.14 Bituminous Lined Corrugated Steel Pipe [1-inch (25 mm) Corrugations]. Provide pipe according to 707.02 and AASHTO M 190, Type D.

707.15 Corrugated Steel Box Culverts. Provide corrugated steel box culverts according to ASTM A 964.

Ensure that all manufacturers are pre-approved. Ensure that manufacturers not pre-approved submit a structural design criteria and analysis method to the Department before the project letting for approval. The Department maintains a list of all pre-approved manufacturers.

Ensure that the manufacturer submits shop drawings and design calculations for review and written approval before manufacture. Submit a minimum of seven copies of the drawings. Allow a minimum of four weeks for approval. Ensure that the shop drawings include the following:

A. All structural design and loading information.
B. All material specifications.
C. All plan view.
D. All elevation view.
E. All headwall and wingwall attachment requirements.
F. All dimensions.
G. All maintenance of traffic phases.
H. All plate size and dimensions.

The manufacturer may modify an approved shop drawing and resubmit for approval to the Department.

707.17 Spiral Rib Steel Pipe Arch. Provide conduits according to AASHTO M36, Type IIA, with the following modifications:

6.1 Fabricate pipe from aluminum coated sheet according to AASHTO M 274.

7.2.2 The ribs shall conform to AASHTO M 196, Section 7.2.2.

9.1 Coupling bands shall have annular corrugations.

9.2 Coupling bands shall conform to 707.01.

14.1 Ensure that the certification and sampling conforms to 707.01.

Ensure that the minimum wall thickness of Spiral Rib steel pipe arches is as follows:

Pipe-Arch

Size (inch)	Wall Thickness (inch)		Size (mm)	Wall Thickness (mm)
20 × 16	0.079		500 × 410	2.01
23 × 19	0.079		580 × 490	2.01
27 × 21	0.079		680 × 540	2.01
33 × 26	0.079		830 × 670	2.01
40 × 31	0.079		1010 × 790	2.01
46 × 36	0.079		1160 × 920	2.01
53 × 41	0.109		1340 × 1050	2.77
60 × 46	0.109		1520 × 1170	2.77
66 × 51	0.109		1670 × 1300	2.77
73 × 55	0.109		1850 × 1400	2.77
81 × 59	0.138		2050 × 1500	3.51

707.18 Polymer Precoated, Galvanized Steel Conduits with precoated galvanized smooth steel interior liner. Provide Type IA pipe which has a corrugated exterior with a smooth interior liner. Provide corrugated exterior conduits and smooth liners according to 707.04 with the following modifications to AASHTO M 245:

7.5.1 Provide Polymer Precoated, Galvanized Steel Conduits with precoated galvanized smooth steel interior liner pipe with plain cut helical ends. Match mark ends. Install conduit so that match marks align and are in accordance with the layout drawings supplied by the manufacturer.

Provide external flat sheet coupling bands with a minimum wall thickness (coated) of .064 inch and that are a minimum of 12" wide. Ensure coupling bands are polymer precoated, galvanized steel.

9.3 Ensure a soil tight joint by the use of a flat gasket conforming to ASTM D1056 2B1 that is a minimum of 12" wide and centered over the joint.

707.19 Aluminum Coated Steel Conduits with precoated galvanized smooth steel interior liner. Provide Type IA pipe which has a corrugated exterior with a smooth interior liner. Ensure that the interior liner conforms to 707.04. Ensure that the corrugated exterior conduit material conforms to AASHTO M274. Provide corrugated exterior conduits per 707.01 or 707.02 with the following modifications to AASHTO M36:

7.7.1 Provide Aluminum Coated Steel Conduits with precoated galvanized smooth steel interior liner pipe with plain cut helical ends. Match mark ends. Install conduit so that match marks align and are in accordance with the layout drawings supplied by the manufacturer.

9.2 Provide external flat sheet coupling bands with a minimum wall thickness (coated) of .064 inch and that are a minimum of 12" wide. Ensure coupling bands are aluminum coated steel.

9.5 Ensure a soil tight joint by the use of a flat gasket conforming to ASTM D1056 2B1 that is a minimum of 12" wide and centered over the joint.

707.20 Galvanized Coated Steel Conduits with precoated galvanized smooth steel interior liner. Provide Type IA pipe which has a corrugated exterior with a smooth interior liner. Ensure that the interior liner conforms to 707.04. Ensure that the corrugated exterior conduit material conforms to AASHTO M 218. Provide corrugated exterior conduits per 707.01 and 707.02 with the following modifications to AASHTO M36:

7.7.1 Provide Galvanized Coated Steel Conduits with precoated galvanized smooth steel interior liner pipe with plain cut helical ends. Match mark ends. Install conduit so that match marks align and are in accordance with the layout drawings supplied by the manufacturer.

9.2 Provide external flat sheet coupling bands with a minimum wall thickness (coated) of .064 inch and that are a minimum of 12" wide. Ensure coupling bands are galvanized coated steel.

9.5 Ensure a soil tight joint by the use of a flat gasket conforming to ASTM D1056 2B1 that is a minimum of 12" wide and centered over the joint.

707.21 Corrugated Aluminum Alloy Conduits and Underdrains. Provide conduits and underdrains having a 1/4, 7/16, or 1/2-inch (6.5, 11, or 13 mm)

corrugation depth and according to AASHTO M 196/M 196M, with the following modifications:

8.1 and 8.2 Provide helically corrugated pipe 12 inches (300 mm) in diameter and larger that have at least two circumferential corrugations at each end of each pipe length.

8.1.2 Ensure that the minimum wall thickness of aluminum pipe and pipe arches is as follows:

Pipe			Pipe-Arch	
Diameter (inch)	**Wall Thickness (inch)**		**Size (inch)**	**Wall Thickness (inch)**
6	0.048			
8	0.060			
10	0.060			
12	0.060			
15	0.060		17 × 13	0.060
18	0.060		21 × 15	0.060
21	0.060		24 × 18	0.060
24	0.060		28 × 20	0.075
27	0.075			
30	0.075		35 × 24	0.075
36	0.075		42 × 29	0.105
42	0.105		49 × 33	0.105
48	0.105		57 × 38	0.135
54	0.105		64 × 43	0.135
60	0.135		71 × 47	0.164
66	0.164			
72	0.164			

Pipe			Pipe-Arch	
Diameter (mm)	Wall Thickness (mm)		Size (mm)	Wall Thickness (mm)
150	1.22			
200	1.52			
250	1.52			
300	1.52			
375	1.52		430 × 330	1.52
450	1.52		530 × 380	1.52
525	1.52		610 × 460	1.52
600	1.52		710 × 510	1.91
675	1.91			
750	1.91		885 × 610	1.91
900	1.91		1060 × 740	2.67
1050	2.67		1240 × 840	2.67
1200	2.67		1440 × 970	3.43
1350	2.67		1620 × 1100	3.43
1500	3.43		1800 × 1200	4.17
1650	4.17			
1800	4.17			

Ensure that the minus tolerance conforms to AASHTO M 197/M 197M.

9.2 Provide coupling bands with a minimum wall thickness (coated) of 0.060 inch (1.52 mm). For pipe diameters 12 inches (300 mm) and larger, provide coupling bands that have at least one circumferential corrugation that indexes into the inboard corrugations of each pipe section joined.

707.22 Corrugated Aluminum Alloy Conduits. Provide conduits having a 1-inch (25 mm) corrugation depth and according to AASHTO M 196/M 196M, with the following modifications:

8.1 and 8.2 Provide helically corrugated pipe that have at least two circumferential corrugations at each end of each pipe length.

8.1.2 Ensure that the minimum wall thickness of aluminum pipe is as follows:

Pipe

Diameter (inch)	Wall Thickness (inch)		Diameter (mm)	Wall Thickness (mm)
36	0.060		900	1.63
42	0.060		1050	1.63
48	0.060		1200	1.63
54	0.075		1350	1.91
60	0.105		1500	2.67
66	0.105		1650	2.67
72	0.105		1800	2.67
78	0.105		1950	2.67
84	0.105		2100	2.67
90	0.105		2250	2.67
96	0.105		2400	2.67
102	0.135		2550	3.43
108	0.135		2700	3.43
114	0.164		2850	4.17
120	0.164		3000	4.17

Ensure that the minus tolerance conforms to AASHTO M 197/M 197M.

9.2 Provide coupling bands that are not lighter than 0.060-inch (1.52 mm) nominal sheet thickness and that have at least one circumferential corrugation that indexes into the inboard corrugations of each pipe section joined.

707.23 Aluminum Alloy Structural Plate Conduits. Provide aluminum alloy plates and fasteners for structural plate conduits according to AASHTO M 219/M 219M.

707.24 Corrugated Aluminum Spiral Rib Conduits. Provide conduits that have a center-to-center rib spacing of 7 1/2 inches (190 mm). Provide conduits and fittings according to AASHTO M 196, Type IR, with the following modifications:

7.5.1 Reroll the ends of the individual pipe sections to form at least two annular corrugations on each end.

8.1.2 Ensure that the minimum wall thickness of aluminum pipe is as follows:

Pipe

Diameter (inch)	Wall Thickness (inch)		Diameter (mm)	Wall Thickness (mm)
18	0.060		450	1.52
21	0.060		525	1.52
24	0.060		600	1.52
30	0.060		750	1.52
36	0.075		900	1.91
42	0.105		1050	2.67
48	0.105		1200	2.67
54	0.105		1350	2.67
60	0.135		1500	3.43
66	0.135		1650	3.43

9.1 Coupling bands shall have annular corrugations.

9.2 Coupling bands shall conform to 707.21.

14.1 Ensure that the certification and sampling conforms to 707.21.

707.25 Corrugated Aluminum Box Culverts. Provide corrugated aluminum box culverts according to ASTM B 864/B 864M.

Ensure that all manufacturers are pre-approved. Ensure that manufacturers not pre-approved submit a structural design criteria and analysis method to the Department before the project letting for approval. The Department maintains a list of all pre-approved manufacturers.

Ensure that the manufacturer submits shop drawings and design calculations for review and written approval before manufacture. Submit a minimum of seven copies of the drawings. Allow a minimum of four weeks for approval. Ensure that the shop drawings include the following:

A. All structural design and loading information.
B. All material specifications.
C. All plan view.
D. All elevation view.
E. All headwall and wingwall attachment requirements.
F. All dimensions.
G. All maintenance of traffic phases.
H. All plate size and dimensions.

The manufacturer may modify an approved shop drawing and resubmit for approval to the Department.

707.31 Corrugated Polyethylene Drainage Tubing. Provide corrugated polyethylene drainage tubing according to AASHTO M 252 Type C, and CP. If Type S or SP is specified, provide corrugated polyethylene smooth lined pipe conforming to 707.33.

Only provide materials from manufacturers certified according to Supplement 1066.

707.32 Corrugated Polyethylene Drainage Pipe. Provide conduits, coupling bands, and fittings according to AASHTO M 294, Type C.

Only provide materials from manufacturers certified according to Supplement 1066.

707.33 Corrugated Polyethylene Smooth Lined Pipe.

Provide smooth lined corrugated polyethylene pipe, closed profile polyethylene pipe, couplings, and fittings conforming to AASHTO M 294, with the following modifications:

Provide Type S or Type D. If perforated is specified, provide Type SP.

1.1.1 Nominal sizes of 4 to 60 inches (100 mm to 1500 mm) are included.

7.2.1 In addition, nominal diameters of 4, 6, 8, and 10 inches (100, 150, 200, and 250 mm) are included.

7.2.2 For the additional nominal diameters listed for 7.2.1 the inner liner of Type S and SP pipe, and both inner and outer walls of Type D pipe shall have the following minimum thicknesses:

Diameter		Inner Wall Thickness	
(inch)	(mm)	(inch)	(mm)
4	100	0.020	0.50
6	150	0.020	0.50
8	200	0.025	0.60
10	250	0.025	0.60

7.4 For the additional nominal diameters listed for 7.2.1 the pipe shall have a minimum pipe stiffness at 5 percent deflection as follows:

Diameter		Pipe Stiffness	
(inch)	(mm)	(P/I/I)	(N/m/mm)
4	100	50	340
6	150	50	340
8	200	50	340
10	250	50	340

7.8.5 In addition, couplings for corrugated pipe shall be bell and spigot or bell-bell couplings, or clamp-on bands, for all sizes up to and including 36-inch (900 mm) diameter.

Couplings for Type D pipe shall be a bell-bell or bell and spigot coupling. The coupling may be welded on one end of each length of pipe by means of a full circumferential weld. Stitch welds are not permitted.

Couplings for pipe diameters 42 inches (1050 mm) and larger shall be bell-bell or bell and spigot.

11.1.3 In addition, pipe with diameters 4 through 10 inches (100 through 200 mm) inclusive may be marked “AASHTO M252”.

12.1 Only provide materials from manufacturers certified according to Supplement 1066.

707.34 Polyethylene Plastic Pipe Based on Outside Diameter (OD). Provide polyethylene plastic pipe based on OD, coupling and fittings conforming to ASTM F714 with the following modifications:

1.1 Provide pipes with outside diameters from 10 to 63 inches.

Table 7 Minimum Wall Thickness		
Outside Diameter (inches)	Dimension Ratio	Minimum Wall thickness (inches)
63	32.5	1.938

4.1 Polyethylene Compound. Ensure the resin compound for the pipe and fittings meets the requirements of ASTM D 3350 with a cell classification of PE345464C and a Plastic Pipe Institute designation of PE 3408. Compounds that have higher cell classifications in one or more properties are acceptable if the specified property value is exceeded.

8.1 Provide a letter of certification to cover each shipment of material verifying that it meets specification requirements.

No electro-fusion or internal joints permitted.

707.35 Polyethylene Profile Wall Pipe. Provide polyethylene profile wall pipe, coupling and fittings conforming to ASTM F894 with the following modifications:

1.1 Provide pipes with inside diameters from 12 to 132 inches. No electro-fusion joints permitted.

4.3 No electro-fusion joints permitted.

6.5 Delete.

10.1 Provide a letter of certification to cover each shipment of material verifying that it meets specification requirements.

707.41 Smooth-Wall Polyvinyl Chloride Underdrain Pipe. Provide smooth wall perforated and non-perforated PVC plastic pipe and fittings according to ASTM F 758, Type PS 46 minimum, with the following modifications:

7.2.4 Perforated pipe shall have a minimum of four rows of perforations.

Furnish materials according to the Department's QPL.

707.42 Polyvinyl Chloride Corrugated Smooth Interior Pipe. Provide PVC corrugated smooth interior pipe, joints and fittings according to ASTM F 949, with the following modifications:

5.2.4 Perforated pipe may be specified.

Furnish materials according to the Department's QPL.

707.43 Polyvinyl Chloride Profile Wall Pipe. Provide PVC open profile wall pipe and fittings with integral bell joints according to ASTM F 794, with the following modifications:

7.2.4 Only molded or fabricated fittings conforming to the requirements of Specification F 794 may be used.

7.5 Ensure a pipe stiffness of 46 or greater.

Furnish materials according to the Department's QPL.

707.45 Polyvinyl Chloride Solid Wall Pipe. Provide PVC solid wall pipe and fittings with nominal size of 4, 6, 8, 10, 12 and 15-inch (100, 150, 200, 250, 300 and 375 mm) diameter according to ASTM D 3034, SDR 35, with the following modifications:

10.1 The retest provisions do not apply.

Furnish materials according to the Department's QPL.

707.46 Polyvinyl Chloride Drain Waste and Vent Pipe. Provide PVC drain, waste, and vent pipe and fittings according to ASTM D 2665, with the following modifications.

8.1 The retest provisions do not apply.

Furnish materials according to the Department's QPL.

707.47 ABS and Polyvinyl Chloride Composite Pipe. Provide ABS and PVC composite pipe and fittings according to ASTM D 2680, with the following modifications.

11.1 The retest provisions do not apply.

13.1 Furnish certified test data as defined in 101.03 to the Engineer.

707.48 Polyvinyl Chloride Large-Diameter Solid Wall Pipe. Provide PVC solid wall pipe and fittings according to ASTM F 679, with the following modifications:

8.1 The retest provisions do not apply.

Furnish materials according to the Department's QPL.

707.51 ABS Drain Waste and Vent Pipe. Provide ABS schedule 40 plastic drain, waste and vent pipe and fittings according to ASTM D 2661, with the following modifications:

6.4.1 Perform inspection at the project site.

9.18.1 The retest provisions do not apply.

10.1 Furnish certified test data as defined in 101.03 to the Engineer.

707.62 Polypropylene Corrugated Single Wall Pipe. Provide polypropylene corrugated single wall pipe for drainage pipe from 3 to 30-inch diameters according to ASTM F 3219, with the following modification:

9.1 Provide a letter of certification to cover each shipment of material verifying that it meets specification requirements.

707.65 Corrugated Polypropylene Smooth Lined Pipe. Provide smooth lined corrugated polypropylene pipe, closed profile polypropylene pipe, couplings, and fittings according to AASHTO M 330, Type S or Type D, with the following modification:

12.1 Provide a letter of certification to cover each shipment of material verifying that it meets specification requirements.

707.70 Welded and Seamless Steel Pipe. Provide welded and seamless steel pipe according to ASTM A 53 or ASTM A 139/A 139M, Grade B, with the following modifications:

20.1 Perform inspection at the project site. Obtain random samples from material delivered to the project site or at other locations designated by the Laboratory.

Furnish materials according to the Department's QPL.

707.75 Glass-Fiber-Reinforced Polymer Mortar Pipe. Provide Glass-fiber-reinforced polymer mortar pipe and fittings for non-pressure applications according to ASTM D 3262 and for pressure applications according to ASTM D 3754 with the following modifications:

4.1 Provide a minimum pipe stiffness of 18 psi.

7.2 Furnish certified test data as defined in 101.03 to the Engineer.

707.80 Reinforced Thermosetting Resin Pipe. Provide reinforced thermosetting resin pipe and fittings according to ASTM D 2996.The short-term rupture strength hoop tensile stress shall be a minimum 30,000 psi (207 MPa).

Test pipe according to a) ASTM G 154 for 2,500 hrs of accelerated weathering following cycle 2 as defined in Appendix X2, or b) ASTM G 155 for a minimum of 1,250 hours of accelerated weathering following a minimum of cycle 1 as defined in Appendix X3.

After testing, the surface of the pipe will show no fiber exposure, crazing, or checking, and may have only a slight chalking. After testing, the color change of the glass resin sample shall show a Delta E, using L*a*b color space, of less than 3.5.

Use adhesive recommended by the manufacturer for joining pipe and fittings.

Pigmented resin will be used throughout the pipe wall thickness.

Furnish certified test data as defined in 101.03 to the Engineer showing compliance with these specifications.

707.85 Steel Reinforced Thermoplastic Ribbed Pipe. Provide steel reinforced thermoplastic ribbed pipe according to ASTM F2562 with the following modifications:

4.3.2 Delete

4.3.3 Only extrusion welding and external gasketed couplers are permitted.

6.2.2 Furnish only non-perforated pipe with dimensions from Table 2. Furnish pipe with nominal pipe size that is at least 30-inches and no greater than 120-inches.

6.2.7 Delete

8.3.5 Delete

9.1 Install all pipe according to the Department's specifications

10.1 Submit a letter of certification from the manufacturer that states the product was manufactured and tested according to ASTM F2562.

708 PAINT

708.01 Inorganic Zinc Silicate Primer Paint. Provide inorganic zinc silicate primer paint conforming to AASHTO M 300, Type I, and the following modification:

5.1 A green colorant approximately AMS-595A-34159.

Follow the submittal requirements of Supplement 1084 to obtain approval of materials conforming to this specification.

Once the Director approves the paint, the Department will not require further performance testing by the manufacturer unless the formulation or manufacturing process has been changed, in which case the Department will require new certified test results.

Furnish materials certified according to S 1084 and listed on the Department's QPL.

708.02 OZEU Structural Steel Paint. This specification covers the formulation and testing of a three-coat structural steel paint system consisting of an organic zinc prime coat, an epoxy intermediate coat, and a urethane finish coat (OZEU). Material requirements for the respective coats are as follows:

A. General. For each lot of all coatings, furnish a coated card (Drawdown card) that shows the color, gloss, and general appearance of the material covered by the lot. Use a minimum card size of 3 inches by 5 inches. The color must match the color card furnished for the Contract or order within visual limits determined by the Engineer. In case of disagreement, provide test data according to ASTM D 2244 showing a color difference of no greater than 2.0, ΔE^* (CIE 1976 L*a*b*).

B. Organic Zinc Prime Coat. Provide an organic zinc prime coat consisting of a zinc dust filled, two or three-component epoxy polyamide, and selected additives as required. The coating shall also meet the following:

1. Physical Requirements.

a. Total solids, % by weight of paint, ASTM D 2369. 70 percent minimum.

b. Pigment, % by weight of total solids, ASTM D 2371. 83 percent minimum.

c. Total zinc dust, % by weight of pigment. ASTM D 521. 93 percent minimum.

d. Total zinc, % by weight of total solids (by calculation) ASTM D 521. 77 percent minimum.

e. Total solids, % by volume, ASTM D 2697. 45 percent minimum.

f. Color. Greenish gray, approximating AMS-595A-34159, visual comparison.

g. Pot life. Follow the paint manufacturers recommendations for applying the coating within the pot life specified with no evidence of gellation. The coating will be in a free-flowing condition and easily sprayed.

2. Qualitative Requirements.

a. Mixing. Section 6.1, SSPC-Paint 20 using only a high shear (Jiffy) mixer.

b. Storage Life. Section 6.3, SSPC-Paint 20.

c. Mudcracking. Section 7.1, SSPC-Paint 20.

3. Material Quality Assurance. Analysis for each component.

Material Quality Assurance will conform to the requirements of Supplement 1084.

C. Epoxy Intermediate Coat. Provide a two-part epoxy intermediate coat composed of a base component and curing agent suitable for application over the zinc rich primer.

The base component shall contain an epoxy resin together with color pigments, mineral fillers, gellant, leveling agent, and volatile solvents. The curing agent component will contain a liquid polyamide resin and volatile solvent. The coating shall also meet the following:

1. Physical Requirements.

a. Color. White, meeting or exceeding, AMS-595A-37875 according to ASTM E 1347**.**

b. Components. Two, mixed before application.

c. Volume solids, ASTM D 2697. 50 percent minimum.

d. Pot life. Follow the paint manufacturers recommendations for applying the coating within the pot life specified with no evidence of gellation. The coating will be in a free-flowing condition and easily sprayed.

e. Curing time.

(1) Set-to-touch, ASTM D 1640. 4 hours, maximum at 77 °F (25 °C).

(2) Dry-to-recoat, ASTM D 1640. 24 hours, maximum at 77 °F (25 °C).

f. Fineness of grind, ASTM D 1210. Hegman 3 minimum.

g. Volatile Organic Compounds (VOC), maximum, ASTM D 3960. 2.83 lb/gal(340 g/L), as applied.

2. Material Quality Assurance. Material Quality Assurance will conform to the requirements of Supplement 1084.

D. Urethane Finish Coat. Provide a two-component urethane finish coat composed of a polyester and/or acrylic aliphatic urethane and suitable for use as a finish coat over the white epoxy polyamide intermediate coat. The coating shall also meet the following:

1. Physical Requirements.

a. Finish, Specular gloss, ASTM D 523. Use AMS-595A-16440 Gray: 70 % minimum after 3000 hours weathering resistance. Color change less than 2.0 ΔE*, (C.I.E 1976 L*a*b*) ASTM D2244.

b. Volume solids, ASTM D 2697. 42 percent minimum.

c. Curing time, at 77 °F (25 °C) and 50% RH. Set-to-touch, ASTM D 1640: 30 minutes, minimum; 4 hours, maximum.

d. Pot life. Follow the paint manufacturers recommendations for applying the coating within the pot life specified with no evidence of gellation. The coating shall be in a free-flowing condition and easily sprayed

e. Volatile Organic Compounds (VOC), maximum, ASTM D 3960. 2.83 lb/gal(340 g/L), as applied.

f. Colors.

(1) Specified.[2]

Brown	AMS-595A, 10324
Green	AMS-595A, 14277
Blue	AMS-595A, 15526

[2] If not defined in the plans, the Engineer will specify from the list

(2) Elective. As specified on the plans.

g. Gloss requirements, ASTM D 523.

Full gloss	minimum 80% unless specified on the plans
Semi-gloss	30 to 45%
Lusterless (Matte)	maximum 6%

2. Material Quality Assurance. Material Quality Assurance will conform to the requirements of Supplement 1084.

Performance Requirements. Test the coating system, which consists of the organic zinc prime coat, the epoxy intermediate coat, and the urethane topcoat, prior to use.

Prepare three panels for each of the specified tests according to ASTM D 609, except provide a minimum thickness of 1/8 inch (3 mm) and use ASTM A 36/A 36M hot rolled steel. Blast clean the surface to equal, as nearly as is practical, the standard Sa 2 1/2 of ASTM D 2200 (Steel Structures Painting Council SSPC-SP10 meets this requirement). Ensure that the surface has a nominal height of profile of 1 to 3.5 mils (25 to 88 μm) verified by using appropriate replica tape. Coat and cure the panels according to the manufacturer's printed instructions. Provide a dry film coating thickness for the system to be tested as follows:

Organic Zinc:	3.0 to 5.0 mils (75 to 125 μm)
Epoxy:	5.0 to 7.0 mils (125 to 175 μm)
Urethane:	2.0 to 4.0 mils (50 to 100 μm)

The coating system shall pass each of the following tests:

A. Fresh Water Resistance Test (ASTM D 870). Scribe the panels according to ASTM D 1654 to the depth of the base metal in the form of an "X" having at least 2-inch (50 mm) legs, and immerse panels in fresh tap water at 75 ± 5 °F (25 ± 3 °C). After 30 days of immersion, examine the panels to verify that they show no rusting and that the coating shows no blistering, softening, or discoloration. Rate blistering according to ASTM D 714.

B. Salt Water Resistance Test (ASTM D 870). Scribe the panels as specified in "A" above, and immersed panels in a water solution of 5 percent sodium chloride at 75 ± 5 °F (25 ± 3 °C). After 7, 14, and 30 days of immersion, examine the panels to verify that they show no rusting and that the coating shows no blistering or softening. Rate blistering according to ASTM D 714. Replace the sodium chloride solution with a fresh solution after examination at 7 and 14 days.

C. Weathering Resistance Test. Test the panels according ASTM D 4587, Method D, using Ultra Violet A 340 bulbs. Place the panels on test at the beginning of a wet cycle. After 3000 hours of continuous exposure, examine the panels to verify that they show no rusting and that the coating shows no blistering or loss of adhesion. Perform the 60 degree specular gloss measurements on the sprayed panels utilized for this test. Average the three initial measurements (one per panel) together. Also, average the three final measurements together.

D. Salt Fog Resistance Test. Scribe the panels as specified in "A" above, and test them according to ASTM B 117. After 3000 hours of continuous exposure, examine the coating to verify that it shows no loss of bond and that it shows no rusting or blistering beyond 1/16 inch (2 mm) from the center of the scribe mark. Rate blistering according to ASTM D 714.

E. Adhesion Test, ASTM D 4541 Type IV. Test the panels according to the following:

1. Lightly sand the coating surface and aluminum dolly, and apply a quick set adhesive.

2. Allow adhesive to cure overnight.

3. Scribe the coating and adhesive around the dolly before testing.

4. Make a minimum of 4 trials to failure, and report the 4 trials. Ensure that each trial is greater than 400 pounds per square inch (2.8 MPa). Reject trial if fracture at the primer-blast interface occurs.

F. Pencil Hardness Test, ASTM D 3363. Determine the hardness of an individual coat or the coating system by performing a Pencil Hardness Test according to ASTM D 3363. Meet or exceed scale of hardness HB for the coating.

Prequalification. Before approval, submit copies of the manufacturer's certified test data showing that the coating system complies with the performance requirements of this specification to the Laboratory Ensure that the certified test data also states the following physical properties for each coating: Density, pounds per gallon (g/mL); Solids, percent by weight; Solids, percent by volume; Viscosity; Drying time; and VOC content, pounds per gallon (g/mL).

Use an independent testing laboratory, approved by the Laboratory, to develop the test data. Include with the test data the brand name of the paint, name of manufacturer, number of lots tested, and date of manufacture.

Once the Director approves the coating, the Department will not require further performance testing by the manufacturer unless the formulation or manufacturing process has been changed, in which case the Department will require new certified test results.

Sampling. The Laboratory will establish acceptance variances.

Furnish materials certified according to S 1084 and listed on the Department's QPL.

709 REINFORCING STEEL

709.00 Epoxy Coated Steel Reinforcement. Provide epoxy coated reinforcing steel according to ASTM A 775. Furnish certified material according to Supplement 1068.

Mechanical splices of epoxy coated steel reinforcement shall be in accordance with 709.19.

The following modifications apply to ASTM A 775:

5.1 Ensure that steel reinforcing bars to be coated are deformed and conform to 709.01, 709.03, or 709.05, and are free of oil, grease, or paint.

5.2 Ensure that the coating material meets the requirements listed in Annex A1 and is a color that facilitates inspection of the installed bar.

8.3.1 Evaluate the adhesion of the coating by bending production coated bars around a mandrel of specified size according to the bending tables in ASTM A 615 (ASTM A 615M) or ASTM A 996 (ASTM A 996M) as applicable. Perform the bend test for adhesion of the coating at a uniform rate, and ensure that it takes up to

90 seconds to complete. Place the two longitudinal deformations in a plane perpendicular to the mandrel radius, and ensure that the test specimens are at thermal equilibrium between 68 and 86 °F (20 and 30 °C).

12.1 Random sampling for ODOT's QA testing requires three 30-inch samples for each bar size delivered to ODOT projects.

14.1 Report of test results required.

Where reinforcing bar cages for prestressed concrete beams are fabricated by tack welding, patch the areas damaged by the tack welding according to ASTM A 775, Section 11, permissible Amount of Damaged Coating and Repair of Damaged Coating.

709.01 Deformed and Plain Billet Steel Bars for Concrete Reinforcement. Provide deformed and plain billet steel bars for concrete reinforcement according to ASTM A 615 (ASTM A 615M), with the following modification:

13.1 Where positive identification of a heat can be made, perform one tension test and one bend test from each bar designation number of each heat in the Lot. Where identification of the heat is not practical, perform one tension test and one bend test for each bar designation number in each lot of 10 tons (10 metric tons) or fraction thereof.

Furnish certified material according to Supplement 1068.

709.03 Rail Steel Deformed and Plain Bars for Concrete Reinforcement. Provide rail steel deformed and plain bars for concrete reinforcement according to ASTM A 996/A 996M.

Furnish certified material according to Supplement 1068.

709.05 Axle Steel Deformed and Plain Bars for Concrete Reinforcement. Provide axle steel deformed and plain bars for concrete reinforcement according to ASTM A 996/A 996M.

Furnish certified material according to Supplement 1068.

709.07 Electric- Resistance-Welded Carbon and Alloy Steel Mechanical Tubing. Provide grade 60 carbon steel round tubing with a minimum 60 ksi (414 MPa) yield strength according to ASTM A 513/A 513M, with the following modifications:

14.1 Galvanize both the interior and exterior of the tubing with a minimum thickness of 0.30 oz/ft² (91.5 g/m^2) zinc. If welded tubing is used, re-metallize the outside weld with zinc.

Furnish certified material according to Supplement 1068.

709.08 Cold-Drawn Steel Wire for Concrete Reinforcement. Provide cold drawn steel wire for concrete reinforcement according to ASTM A 82 or ASTM A 1064, with the following modification:

7.2 Completely cover galvanized wire with a coating of pure zinc of uniform thickness, so applied that it will adhere firmly to the surface of the wire. Ensure that the minimum weight of zinc coating is 0.8 ounces per square foot (244 g/m^2) of surface as determined by ASTM A 90.

Furnish certified material according to Supplement 1068.

709.09 Fabricated Steel Bar or Rod Mats for Concrete Reinforcement. Provide fabricated steel bar or rod mats for concrete reinforcement according to ASTM A 184/A 184M, with the following modifications:

4 Use deformed bars.

4.1 Provide longitudinal bars conforming to Grade 60 of 709.01, 709.03, or 709.05.

4.2 Provide longitudinal bars according to 709.01, Grade 60. Provide transverse bars according to 709.01.

Furnish certified material according to Supplement 1068.

709.10 Welded Steel Wire Fabric For Concrete Reinforcement. Provide welded steel wire fabric for concrete reinforcement according to ASTM A 185 or ASTM A 1064.

Furnish certified material according to Supplement 1068.

709.11 Deformed Steel Wire for Concrete Reinforcement. Provide deformed steel wire for concrete reinforcement according to ASTM A 496 or ASTM A 1064.

Furnish certified material according to Supplement 1068.

709.12 Welded Deformed Steel Wire Fabric for Concrete Reinforcement. Provide welded deformed steel wire fabric for concrete reinforcement according to ASTM A 497 or ASTM A 1064.

Furnish certified material according to Supplement 1068.

709.13 Coated Dowel Bars. Provide coated dowel bars according to AASHTO M 254, with the following modifications:

4.1 The core material will consist of steel according to 709.01, 709.03, or 709.05.

Coat all surfaces of dowel bars. Suitably re-coat ends of dowel bars that have been cut to length after coating or have not had the uncoated ends coated during manufacturing or fabrication. Prepare surface and patch uncoated bar ends with material equivalent to the original epoxy coating.

If the Contractor elects to use basket supports for positioning of the above dowel bars as specified in 451.09.B or as shown on the plans, provide a fusion-bonded epoxy coated basket dowel bar assembly. Repair uncoated areas with surface preparation and patching material equivalent to the original epoxy coating.

Suitably repair coating on the dowel bars or baskets damaged during installation.

Do not expose coated dowels to weather or sunlight for a period exceeding 180 days.

Furnish certified material according to Supplement 1068.

709.14 Epoxy-Coated Steel Wire and Welded Wire Fabric for Reinforcement. Provide epoxy coated steel wire and welded wire fabric for reinforcement according to ASTM A 884, with the following modifications:

5.1 Ensure that plain or deformed steel wire or welded wire fabric to be coated conform to 709.08, 709.10, 709.11, or 709.12, and is free of oil, grease, or paint.

8.1 Ensure that the coating thickness conforms to Type A. Provide dry film thickness of 5 to 12 mils (0.13 to 0.31 mm).

8.4 Test coated steel wire or welded wire fabric at the manufacturer's plant before shipment or at other sites as designated by the Laboratory.

Furnish certified material according to Supplement 1068.

709.15 Plastic Supports for Reinforcing Steel. Conform to Supplement 1125.

709.16 Galvanized Steel Reinforcement. Provide galvanized steel reinforcement in accordance with ASTM A767, Class 1 or ASTM A1094.

Galvanized steel reinforcement may be provided as an option to 709.00. Provide to the Engineer written notification and updated Plan sheets for the reinforcement bar lists identifying affected bars.

Mechanical splices of galvanized steel reinforcement shall be in accordance with 709.19.

The following modifications apply to ASTM A767:

5.1 Ensure that steel reinforcing bars to be galvanized are deformed and conform to 709.01, 709.03 or 709.05.

7.3.2 Fabrication after galvanizing: The Department will not accept reinforcement galvanized according to ASTM A767to be fabricated after galvanizing.

8.1 Random sampling for ODOT's QA testing requires three 30-inch samples for each bar size delivered to ODOT projects.

9.2 All damaged coating shall be repaired in accordance with 711.02.

10.1 Report of test results required.

The following modifications apply to ASTM A1094:

5.1 Ensure that steel reinforcing bars to be galvanized are deformed and conform to 709.01, 709.03 or 709.05.

8.1 Random sampling for ODOT's QA testing requires three 30-inch samples for each bar size delivered to ODOT projects.

9.1 All damaged coating shall be repaired in accordance with 711.02.

10.1 Report of test results required.

Furnish certified material according to Supplement 1068.

709.17 Chromium Steel Reinforcement. Provide deformed chromium steel reinforcement in accordance with ASTM A1035, Type CS, Grade 100 unless otherwise specified in the Plans. Furnish certified material according to Supplement 1068.

Mechanical splices of chromium steel reinforcement shall be in accordance with 709.

The following modifications apply to ASTM A1035:

16.2 Report of test results required.

17.1 Random sampling for ODOT's QA testing requires three 30-inch samples for each bar size delivered to ODOT projects.

709.18 Stainless Steel Reinforcement. Provide deformed stainless steel reinforcement in accordance with ASTM A955, Grade 75, UNS Designations S31803, S32205, or S32304. Furnish certified material according to Supplement 1068.

Mechanical splices of stainless steel reinforcement shall be in accordance with 709.19. The following modifications apply to ASTM A955:

19.2 Report of test results required.

20.1 Random sampling for ODOT's QA testing requires three 30-inch samples for each bar size delivered to ODOT projects.

709.19 Mechanical Splice Systems. Provide mechanical splice systems for concrete reinforcement with the following structural requirements:

A. The tensile capacity determined according to the ASTM A1034 Monotonic Tension Test, or similar, shall not be less than 125 percent of the specified yield strength of the bar in tension (Fy).

B. The total slip in the mechanical splice system determined according to the ASTM A1034 Slip Test, or similar, measured after preloading to 5% Fy, loading in tension to 50% Fy and relaxing to 5% Fy, shall not exceed the following:

Bar Size	Maximum Slip (in)
#4 - #6	0.020
#7 - #9	0.028
#10 - #11	0.036

#14	0.048
#18 and larger	0.060

Material and coating for the mechanical splice systems shall be similar and compatible to the spliced reinforcement. Furnish material from the Approved List certified according to Supplement 1134.

Random sampling for ODOT's QA testing requires three mechanical splice samples and six 30-inch long bar samples for each bar size spliced on an ODOT project.

710 FENCE AND GUARDRAIL

710.01 Barbed Wire. Furnish barbed wire according to ASTM A 121 Type A or Type Z, Class 3 Galvanizing, with the following modifications:

6.3.1 Ensure that the weight of zinc coating for various gages of wire composing the strands and barbs are not less than 0.80 ounces per square foot (244 g/m^2) of surface.

7.1 Furnish No. 12 1/2, 13 1/2 or 15 1/2 steel wire gage barbed wire. Ensure that the barbs are four point round steel wire spaced 5 inches (130 mm) center-to-center.

9.1 Select one sample, according to Section 9.2, from each 50 spools or fraction thereof.

9.4 Does not apply

11.1 Perform inspection at the project site.

Furnish certified material according to Supplement 1067.

710.02 Woven Steel Wire Fence, Type 47. Furnish woven steel wire fence according to ASTM A 116, Type Z, Class 3 galvanizing, with the following modifications:

7.1 Ensure that the fence fabric is design number 1047-6.9.

11.1 Perform inspection at the project site.

In addition, ensure that all hardware and attachments are galvanized according to 711.02.

Furnish certified material according to Supplement 1067.

710.03 Chain-Link Fence. Furnish chain-link fence according to AASHTO M 181, with the following modifications:

3.1 Furnish posts, gate frames, and post braces, made of Type I or Type III material. Furnish Type I material conforming to the requirements of Table 710.03-1. Furnish Type III material conforming to the requirements of Table 710.03-2.

Fasten the fabric to the posts using either aluminum alloy or galvanized steel bands or wires. Furnish wires that have a 0.148-inch (3.7 mm) minimum diameter and a zinc coating or steel fasteners that are not less than 0.8 ounces per square foot (244 g/m^2).

Furnish stretcher bars that have a 3/4 × 3/16-inch (19 × 5 mm) cross-section or an equivalent cross-section with a length equal to full height of fabric.

Furnish steel truss rods that have a steel 3/8-inch (9.5 mm) diameter or equivalent cross-section and that have suitable adjustment.

TABLE 710.03-1 STEEL POSTS, GATE FRAMES, AND POST BRACES,

Usage – nominal fence height 6 ft or less	Section Thickness	Outside Diameter or Dimensions (in)	Weight Nominal lb/ft	Tolerance (+/- %)	Minimum Yield Strength (psi)
Line posts	Grade 1 Pipe	2.375	3.65	10	30,000
	Grade 2 Pipe	2.375	3.12	10	50,000
	C-Section	2.250 × 1.700	2.78	10	50,000
	H-Section	2.250 × 1.700	3.26	10	50,000
End, corner pull posts	Grade 1 Pipe	2.875	5.79	10	30,000
	Grade 2 Pipe	2.875	4.64	10	50,000
Gate Posts, for nominal width of gate (single or one leaf of Double):					
Up to 6 ft incl.	Grade 1 Pipe	2.875	5.79	10	30,000
	Grade 2 Pipe	2.875	4.64	10	50,000
Over 6 to 13 ft incl.	Grade 1 Pipe	4.000	9.11	10	30,000
	Grade 2 Pipe	4.000	6.56	10	50,000
Over 13 to 18 feet incl.	Grade 1 Pipe	6.625	18.97	10	30,000
Over 18 feet	Round	8.625	28.58	10	30,000
Gate frames	Grade 1 Pipe	1.900	2.72	10	30,000
	Grade 2 Pipe	1.900	2.28	10	50,000
Tension Wire,[1] post braces	Grade 1 Pipe	1.660	2.27	10	30,000
	Grade 2 Pipe	1.660	1.84	10	50,000
	Roll-form	1.6250 × 1.250	1.35	10	50,000
	Round tubing	1.660	1.38	10	50,000
[1] When tension wire is specified, it will be of 0.177 in diameter.					

TABLE 710.03-1M STEEL POSTS, GATE FRAMES, AND POST BRACES,

Usage – nominal fence height 1.8 m or less	Section Thickness	Outside Diameter or Dimensions (mm)	Weight Nominal (kg/m)	Minimum Tolerance (+/- %)	Yield Strength (MPa)
Line posts	Grade 1 Pipe	60	5.4	10	209
	Grade 2 Pipe	60	4.6	10	345
	C-Section	57 × 43	4.1	10	345
	H-Section	57 × 43	4.9	10	345
End, corner pull posts	Grade 1 Pipe	73	8.6	10	209
	Grade 2 Pipe	73.00	6.9	10	345
Gate Posts, for nominal width of gate (single or one leaf of Double):					
Up to 1.8 m incl	Grade 1 Pipe	73.00	8.6	10	209
	Grade 2 Pipe	73.00	6.9	10	345
Over 1.8 to 4 m incl.	Grade 1 Pipe	102.00	13.6	10	209
	Grade 2 Pipe	102.00	9.8	10	345
Over 4 to 5.5 m incl.	Grade 1 Pipe	168.00	28.2	10	209
Over 5.5 m	Round	219	42.5	10	209
Gate frames	Grade 1 Pipe	48	4.0	10	209
	Grade 2 Pipe	48	3.4	10	345
Tension Wires,[1] post braces	Grade 1 Pipe	42	3.4	10	209
	Grade 2 Pipe	42	2.7	10	345
	Roll-form	41 × 32	2.0	10	345
	Round tubing	42	2.1	10	345
[1] When tension wire is specified, it will be of 4.5 mm diameter.					

Furnish ornamental cap post tops made of steel, malleable iron or cast iron. Furnish them with a hole suitable for through passage of the top rail. Ensure that they fit snugly to the post, have a means of attaching securely to the post, and exclude moisture from tubular posts. Furnish swing type gates complete with latches, stops, keepers, hinges, locks, and fabric. Cover them with fabric matching the fence. Furnish hinges of adequate strength to support the gate and that do not twist or turn under action of the gate. Locate plunger bar type latches at the full gate height in a manner that will engage the gate stop. Forked latches may be used for single gates less than 10 feet (3 m) wide. Furnish lockable latches. Furnish stops that consist of a flush plate with anchor placed in concrete to engage the plunger bar of the latch. Other approved types of stops may be used for single gates less than 10 feet (3 m) wide. Keepers are substantial devices for securing and supporting the free end of the gate in open position.

Furnish top rail couplings consisting of the outside sleeve type at least 6 inches (150 mm) long. Ensure that a minimum of 20 percent of the coupling has an internal heavy spring to take up expansion and contraction.

Furnish gate frames that are assembled by welding, using properly designed, formed sheet, or sandcast fittings. Cover the gates with fabric matching the fence.

Furnish offset type hinges. Furnish galvanized latches, stops, and keepers made of malleable iron, except for plunger bars that may be galvanized tubular or bar steel according to Section 6.2.

Furnish flat stretcher bars in 3/4 × 1/4-inch (19 × 6 mm) sections.

Furnish self-centering outside rail couplings that are 6 inches (150 mm) long.

Furnish tie wire that has a 0.148-inch (3.7 mm) minimum diameter and that meets an aluminum alloy.

Furnish wrought or cast turnbuckles.

Furnish truss and brace rods with an 3/8-inch (9.5 mm) outside diameter or equivalent cross-section.

Furnish beveled brace bands in 1 × 1/8-inch (25 × 3 mm) section.

Furnish bolts with an anodic coating at least 2 mil (5 μm) in thickness, chromate sealed.

11.1. Ensure that the size of the fabric conforms to 0.148-inch (3.7 mm) nominal diameter of coated wire, 2-inch (50 mm) mesh.

14.1 Table 8. Type I Zinc-Coated Steel Chain Link Fabric will have Class D weight of coating.

15.5 Ensure that the vinyl covering is of a uniform medium green color.

19.1 Perform inspection at the project site.

32.2 Does not apply.

32.3.3.2. Increase the minimum weight of interior coating to an average of 0.9 ounces per square foot (275 g/m^2) and not less than 0.8 ounces per square foot (244 g/m^2) on an individual specimen.

TABLE 710.03-2 DIAMETERS OR PLAIN END, SCHEDULE 40 ALUMINUM ALLOY PIPE

The weights and dimensions are as specified in ANSI H 35.2.

		Nominal Pipe Size	
Material		**(in)**	**(mm)**
Brace rails		1 1/4	32
Gate frames and rail couplings		1 1/2	40
Line posts		2	50
End and corner posts		2 1/2	65
Gate posts single or one leaf of double:			
Gate opening			
(ft)	(m)	(in)	(mm)
To 6	To 1.8	2 1/2	65
Over 6 to 12	Over 1.8 to 3.7	3 1/2	90
Over12 to 18	Over 3.7 to 5.5	6	150
Over 18 to 32	Over 5.5 to 9.8	8	200

A 8'-8" line post may be substituted in lieu of the line post shown on standard drawings Chain Link Fence 1.1, 7-28-00 and Walk Gates F-3.2, 7-28-00. This will be accomplished by reducing the 4'-0" depth as necessary to accommodate the shorter posts. All other dimensions shown in the standard drawings shall remain unchanged

Furnish certified material according to Supplement 1067.

710.06 Deep Beam Rail. Furnish deep beam rail according to AASHTO M 180, Type II or VI, Class A, with the following modifications:

5.1 Perform inspection at the project site.

5.2.1 When a field check of coating thickness shows insufficient coating thickness or shows insufficient coating weight, sample and test the guardrail.

9.1.2 The minimum check limits for both triple and single-spot tests apply.

Furnish certified material according to Supplement 1042.

710.09 Wire Rope Rail. Furnish wire rope rail according to AASHTO M 30, Class A, Type I rope, with the following modification:

9 Perform inspection at the project site.

Obtain random samples from material delivered to the project site or at other locations designated by the Laboratory.

710.11 Fence Posts and Braces. Furnish round wood posts conforming to 710.12 and 710.14. Furnish dimension timber, posts, and lumber for braces and stream crossings that are sound, straight, free from unsound or loose knots, splits and shakes, and that are treated according to 712.06.

Furnish steel line posts according to ASTM A 702, with the following modifications:

5.5.2 Furnish fasteners or clamps that have a 0.120-inch (3 mm) diameter and that are galvanized according to ASTM A 116, Type Z, Class 3.

5.5.1 Supply each post with a sufficient number of fasteners or clamps.

6.2 Ensure that the post lengths are as designated.

7.1 Furnish galvanized line posts and anchors according to 711.02.

7.2 Delete.

Furnish certified material according to Supplement 1067.

710.12 Square-Sawed and Round Guardrail Posts. Furnish pressure treated sawed posts of a timber grade in accordance with AASHTO M 168, 710.14, and 712.06. Furnish round guardrail posts according to 710.12, 710.14, and 712.06. Cut posts from growing timbers that are free from unsound or loose knots and rot and from injurious or excessive shake, and season checks that exceed 1/4 inch (6 mm) in width.

Ensure that the sweep does not exceed 1 inch (25 mm) for the length of the post. Peel round posts their entire length, removing all outer and inner bark and leather fiber by shaving the surface. Trim knots even with the post, and saw both ends of the post square.

Furnish round posts for the follow species only:

Douglas Fir:

Knot diameter for posts of Douglas Fir shall not exceed 51 mm (2 in.). Ring density for the species shall be at least 6 rings-per-inch as measured over a 76 mm (3 in.) distance. The diameter of the Douglas Fir posts shall be 184 mm (7¼ in.) at the ground line with a upper limit of 203 mm (8 in.).

Southern Pine:

Knot diameter for posts of Southern Pine shall not exceed 64 mm (2½ in.). Ring density for the species shall be at least 4 rings-per-inch as measured over a 76 mm (3 in.) distance. The diameter of the Southern Pine posts shall be 190 mm (7½ in.) at the ground line with a upper limit of 210 mm (8¼ in).

Ponderosa Pine:

Knot diameter for posts of Ponderosa Pine shall not exceed 102 mm (4 in.). Ring density for the species shall be at least 6 rings-per-inch as measured over a 76 mm (3 in.) distance. The diameter of the Ponderosa Pine posts shall be 203 mm (8 in.) at the ground line with an upper limit of 222 mm (8¾ in.).

Species			White Pine	
Maximum Slope of Grain			1 in 15	
Nominal Width of Face			6" [152]	8" [203]
Shakes, Checks, and Splits	Green		1" [25]	1 3/8" [35]
	Seasoned		1 1/2" [38]	2" [51]
Maximum Wane			1" [25]	1 3/8" [35]
Maximum Allowable Knots	Narrow Face	Middle 1/3 of Length	1 3/8" [35]	1 5/8" [41]
		End (1)	2 3/4" [70]	3 1/4" [83]
		Sum in Middle ½ of Length (2)	11" [279]	13" [330]
	Wide Face	Edge Knot in Middle 1/3 of Length	1 3/8" [35]	1 5/8" [41]
		Edge Knot at End (1)	2 3/4" [70]	3 1/4" [83]
		Centerline	1 3/8" [35]	1 7/8" [48]
		Sum in Middle Half of Length	5 1/2" [140]	7 1/2" [190]

Furnish certified material according to Supplement 1072.

710.14 Pressure Treated Guardrail and Fence Posts, Braces, and Blocks. Furnish pressure treated guardrail and fence posts, braces, and blocks according to AASHTO M 133 and 710.11, 710.12, and 712.06.

Furnish certified material according to Supplements 1042 and 1072.

710.15 Steel Guardrail Posts. Furnish steel guardrail posts in the sections and lengths as specified. Ensure that they are made of copper bearing steel when so specified. Furnish steel according to ASTM A 36/A 36M. Furnish galvanized posts according to 711.02.

Furnish certified material according to Supplement 1042.

710.16 Guard Posts. Furnish pressure treated wood posts according to 710.14. Furnish posts that are either sawed 5 by 6 in (125 by 150 mm) in cross section or 5 1/2 in + 1/2 in (138 mm) diameter round when measured 30 inches (0.75 m) from the top. Furnish posts that are 5 feet, 3 inches (1.6 m) in length and are embedded such that 30 inches (0.75 m) remains exposed. Ensure that the center-to-center spacing is spaced at 6 feet (1.8 m) intervals, unless otherwise shown on the plans.

Furnish certified material according to Supplement 1042.

711 STRUCTURAL STEEL AND STRUCTURE INCIDENTALS

711.01 Structural Steel. Furnish structural steel conforming to ASTM A 709, Grade 36 (A36), 50 (A572), 50W (A588), or 70W.

Ensure that materials designated to meet notch toughness requirements have a minimum longitudinal Charpy V-Notch (CVN) energy absorption value as listed below. Sample and test according to ASTM A 673/A 673M. Use the (H) frequency of heat testing and provide the test data as required by 501.06.

ASTM Designation	Thickness and Connection Method	Value Min CVN
A709 Gr. 36 (A36, A36M)	Up to 4 in (102 mm) mechanically fastened or welded	15 ft-lb @ 40 °F (20 J @ 4 °C)
A709 Gr. 50 (A 572/A 572M), A709 Gr. 50W (A 588/A 588M)	Up to 4 in (102 mm) mechanically fastened	15 ft-lb @ 40 °F [1] (20 J @ 4 °C)
A709 Gr. 50 (A 572/A 572M), A709 Gr. 50W (A 588/A 588M)	Over 2 to 4 in (51 to 102 mm) welded	20 ft-lb @ 40 °F [1] (20 J @ 4 °C)
A709 Gr. 50 (A 572/A 72M), A709 Gr. 50W (A 588/A 588M)	Up to 2 in (51 mm) welded	15 ft-lb @ 40 °F [1] (20 J @ 4 °C)
A709 Gr. 70W	Up to 4 in (100 mm) mechanically fastened or welded	25 ft-lb @ -10 °F [1] (34 J @ -23 °C)

[1] If the yield point of the material exceeds 65 ksi (448 MPa), the temperature of the CVN value for acceptability should be reduced by 15 °F (8.3 °C) for each increment, or part of increment, of 10 ksi (69 MPa) above 65 ksi (448 MPa).

[2] If the yield point of the material exceeds 85 ksi (585 MPa), the temperature of the CVN value for acceptability should be reduced by 15 °F (8.3 °C) for each increment, or part of increment, of 10 ksi (69 MPa) above 85 ksi (585 MPa).

[3] The CVN-impact testing shall be at "P" frequency in accordance with ASTM A673.

711.02 Galvanized Steel. Furnish galvanize steel according to ASTM A 123 after cutting, bending, and welding. At the discretion of the Engineer, replace, re-galvanize, or repair damaged galvanized material. If a repair is authorized, perform work according to ASTM A 780 except the Department will not allow aerosol spray applications of paints containing zinc dust.

Coat ASTM F3125 fasteners according to 711.09. Furnish all other bolts, nuts, washers, and similar threaded fasteners that are galvanized according to ASTM A 153 or ASTM F2329. These items may be mechanically zinc coated according to ASTM B 695, Class 50

711.03 Steel for Piling. Furnish steel for H-piling conforming to ASTM A 572 Grade 50 / A 572M Grade 345. Furnish steel for sheet piling according to ASTM A 328/A 328M. Furnish steel for cast-in-place reinforced concrete piles conforming to ASTM A 252, Grade 2 or 3.

711.04 Cold Rolled Steel. Furnish cold rolled steel according to ASTM A 108, Grades 1016 through 1030 for pins, rollers, trunnions, and other similar parts.

711.07 Steel Castings. Furnish steel castings according to ASTM A 27/A 27M, Grade 65-35 or Grade 70-36, or AASHTO M103, or ASTM A 148, Grade 90-60, with the following modification:

Ensure that steel castings are free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength and value for the service intended. No sharp, unfilleted angles or corners are allowed.

711.08 Arc-Welding Electrodes and Fluxes. The following applies to all steel, except for exposed bare ASTM A 242/A 242M and ASTM A709 Grade 50W (A 588/A 588M) steels. For exposed bare ASTM A 242/A 242M and A709 Grade 50W (A 588/A 588M) applications, see Table 711.08-1.

A. Manual shielded metal-arc welding.

1. AWS A5.1 Low Hydrogen Only
2. AWS A5.5 Low Hydrogen Only

B. Submerged Arc Welding

1. AWS 5.17[5]
2. AWS 5.23[5]

C. Gas metal-arc welding, AWS A 5.18[5]

D. Flux cored arc welding, AWS A5.20[5]

TABLE 711.08-1

Filler metal requirements for exposed bare applications of ASTM A 242/A 242M and ASTM A709 Grade 50W (A 588/A 588M) steel.

Welding Process		
Shielded metal arc	**Submerged arc [5]**	**Gas metal arc or Flux cored arc [2],[4], [5]**
AWS A5.5	AWS A5.23	AWS A5.28 and 5.29
E8015, 8016, or 8018 electrodes that deposit weld metal meeting C1, C1L, C2, C2L, C3, or W analysis	All electrode-flux combinations that deposit weld metal with a Ni1, Ni2, Ni3, Ni4, or W analysis [2],[3]	All electrode-flux combinations that deposit weld metal with a Ni1, Ni2, Ni3, Ni4, or W analysis

[2] Deposited weld metal will have a minimum impact strength of CVN 20 ft-lb (27 J) at 0 °F (-18 °C) (only applied to bridges).

[3] The use of the same type filler metal having next higher mechanical properties as listed in AWS specification is permitted.

[4] Deposited weld metal will have a chemical composition the same as that for any one of the weld metals in this table for the shielded metal arc welding process.

[5] In conformance with those classifications allowed under AWS D1.5 *Bridge Welding Code*, Tables 4.1 and 4.2.

The Laboratory will issue a list of approved electrodes and combinations of shielding. The Laboratory will include electrodes in the list when certified test data submitted by the manufacturer is found in compliance with the specified requirements. The certification will cover either process qualification or quality control tests. To qualify, such tests must be made within one year before the period

covered. For each submission of certified test data, include the manufacturer's statement that it will advise the Laboratory immediately of any change in materials or processing used in the manufacture of the electrodes made within one year from the date of the tests.

When electrodes to be used are not included in the Laboratory's list of approved electrodes and combinations of shielding, submit certified test data as described above for each lot showing compliance with the specified requirements.

711.09 High-Strength Steel Bolts, Nuts, and Washers. Furnish high-strength steel bolts, nuts, and washers according to ASTM F3125 Grade A 325 (A 325M), with the following modification:

If necessary for approval, obtain samples from material delivered to the project site or at other locations designated by the Laboratory.

Furnish bolts for steel use in bare unpainted applications according to ASTM F 3125 Grade A 325 (A 325M), Type 3.

Use zinc coated bolts to fasten steel that has received an inorganic zinc prime coat according to 514.

Furnish high-strength steel bolts, nuts, and washers that also meet the requirements of Supplement 1080.

Provide samples to the Laboratory for acceptance.

711.10 Machine Bolts. Furnish bolts according to ASTM F1554, with the following modification:

If necessary for approval, obtain samples from material delivered to the project site or at other locations designated by the Laboratory.

Mechanical galvanizing is permitted.

711.12 Gray Iron Castings. Furnish gray iron casting according to ASTM A 48, Class 30B, with the following modifications:

12 Two or more test bars will accompany each lot of castings or; one pair of test bars may represent castings shipped to two or more projects provided the lot number or date cast are cast or anchored in both the bars and castings. The identifying data or castings shall not interfere with the use of the casting.

9 In addition, ensure that castings are free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength and value for the service intended. Ensure that the castings are generously filleted at angles and the arrises are sharp and perfect.

17 Ship test bars with the lot or make test bars representing the lot available to the Laboratory at the place of manufacture or warehouse.

711.13 Ductile Iron Castings. Furnish ductile iron castings according to ASTM A 536, with the following modifications:

8.1 In addition, ensure that castings are free from pouring faults, sponginess, cracks, blowholes, and other defects in positions affecting their strength. Ensure that the castings are generously filleted at angles and arrises are sharp and perfect.

10.1 Send a keel block or Y-block specimen made according to ASTM A 536 with the shipment for each heat number, ladle number, and date of casting.

14.1 Submit a certification stating that the test bars shipped with the castings were prepared according to the specified requirements.

711.14 Gray Iron and Ductile Iron Castings. Furnish gray iron and ductile iron castings according to AASHTO M 306, Class 35B, with the following modifications:

Test bars are required as outlined in 711.12 and 711.13. In addition, submit certified test data for monthly proof load testing to the Laboratory with each inspection of castings from that month.

Design Approval. Submit designs for cast frames, grates and covers for manholes, catch basins and inlets that vary from the standard construction drawings to the Department for approval. Manufacturers will seek approval for such non-standard designs well in advance of a projects sale date.

711.15 Sheet Copper. Furnish sheet copper according to ASTM B 370.

711.16 Phosphor Bronze Plate. Furnish phosphor bronze plate according to ASTM B 100.

711.17 Cast Bronze. Furnish cast bronze according to ASTM B 22, Copper Alloy No. C91100, with the following modification:

Finish cast plates to plane surfaces and finish one plate of a pair at right angles to the other plate of the pair.

711.18 Leaded Bronze. Furnish leaded bronze according to ASTM B 584, Copper Alloy No. C93700, with the following modification:

Finish cast plates to plane surfaces and finish one plate of a pair at right angles to the other plate of the pair.

711.19 Sheet Lead. Furnish sheet lead according to ASTM B 29.

711.20 Aluminum for Railings. Furnish aluminum other than permanent mold castings that conform to the following requirements:

Portion of Railing	ASTM Designation	Alloy	Condition or Temper (B296)
Sand castings	B 26/B 26M	356.0	T6
Shims	B 209 (B 209M)	1100	0
Washers	B 209 (B 209M)	Clad 2024 6061	T4 T6
Sheet and plate	B 209 (B 209M)	6061	T6
Drawn seamless tubes	B 210	6061 or 6063	T6
Bars, rods, wire	B 211 (B 211M)	6061	T6
Bolts, set screws	B 211 (B 211M)	2024 [1] 6061	T4 T6
Nuts	B 211 (B 211M)	6061 6262	T6 T9
Extruded bars, rods, shapes	B 221 (B 221M)	6061 or 6063 6351	T6 T5
Extruded tubes	B 221(B 221M)	6061 or 6063 6351	T6 T5
Pipe	B 241/B 241M	6061 or 6063	T6
Rivets	B 316(B 316M)	6061	T6

[1] Will have an anodic coating.

For permanent mold castings for bridge railing posts, provide aluminum according to AASHTO M 193.

711.21 Preformed Bearing Pads. Composition. Furnish preformed bearing pads consisting of a fabric and rubber body. Ensure that the pad is made with new, unvulcanized, natural and/or synthetic rubber, and unused cotton and/or synthetic fabric fibers in proper proportion to maintain strength and stability.

Physical Properties. The required surface hardness, expressed in standard rubber hardness figures, is 80 ± 10 Shore Durometer. The minimum ultimate break down limit of pads under compressive loading is 10,000 pounds per square inch (69 MPa). Furnish pads to specified dimensions and accurately locate and cleanly cut all bolt holes.

Furnish materials according to the Department's QPL.

711.22 Buried Liner Waterproofing Membrane. Furnish buried liner waterproofing membrane according to ASTM D 7176-06, with the following modification:

Only 4.1.2 through 4.1.6 is approved.

Furnish materials according to the Department's QPL.

711.23 Elastomeric Bearings. Furnish bearing pads and elastomeric bearings conforming to *AASHTO Standard Specifications for Highway Bridges*, Division II, Construction, Chapter 18, Section 18.4.5.1 Grade 3 requirements. Fabricate elastomeric bearing pads according to Sections 18.5.6.1 and 18.5.6.2. Test pads and bearings according to 18.7.1, 18.7.2.1, 18.7.2.3, 18.7.2.5, 18.7.2.6, 18.7.3, 18.7.4.5,

and 18.10.3. Include testing in the price bid for the bearings. Furnish certified material according to Supplement 1081.

Furnish bearing pads and laminated bearings consisting of neoprene cast in molds under pressure and heat. A plain elastomeric bearing pad and steel load distribution plate combination is classified as a laminated elastomeric bearing. Obtain test specimens according to ASTM D 3182 or ASTM D 3183. Where test specimens are cut from the finished product, a 20 percent variation from the original physical properties is allowed. The use of compounds of nominal hardness between the values shown in Table 711.23-1 is permitted and the test requirements interpolated.

TABLE 711.23-1

	Grade		
Physical Properties	**50**	**60**	**70**
Hardness, Durometer A, ASTM D 2240.	50 ± 5	60 ± 5	70 ± 5
Tensile Strength, min psi (MPa), ASTM D 412	2500 (17)	2500 (17)	2500 (17)
Elongation at break, min %	400	350	300
Accelerated Tests to Determine Long-Term Aging Characteristics, Over-Aged 70 hrs at 212 °F (100 °C), ASTM D 573:			
Hardness, points change, max	15	15	15
Tensile strength, % change, max	-15	-15	-15
Elongation at break, % change, max	-40	-40	-40
Ozone 1 ppm in air by volume 20% strain, 104 °F (40 °C) ASTM D 1149, 100 hrs (Samples to be solvent wiped before test to remove any traces of surface impurities)	No cracks	No cracks	No cracks
Compression set 22 hrs/212 °F (100 °C) ASTM D 395, Method B, % max	35	35	35
Adhesion, bond made during vulcanization ASTM D 429 Method B, lb/in (kN/m)	40 (7.0)	40 (7.0)	40 (7.0)

Furnish bearing pads that are individually molded, cut from previously molded strips or slabs, or extruded and cut to length. Mold laminated bearings together into an integral unit with all edges of internal steel laminates covered by a 1/8-inch (3 mm) minimum thickness of elastomer. Fill indentations or grooves on the exterior surface of the bearings caused by external laminate restraining devices to a 1/8 inch (3 mm) minimum cover by a revulcanized patch; or by a silicon caulk conforming to Federal Specifications TT-S-001543A; or by an approved equal. Ensure that the bearing manufacturer patches the bearings.

Ensure that the external connection or distribution plates of laminated bearings are the same material as the attached structural steel and are similarly cleaned and coated. Furnish internal plates according to ASTM A 709 grade 36 or A1011/A1011M, SS Grade 36 or Grade 40. Minimum thickness for the internal plates is 12 Gauge (0.1046 in ; +/- 0.006-in). Debur all plates.

The bearing manufacturer will furnish certified test data for the elastomer, base plate, steel laminates, and proof load.

The bearing manufacturer will produce one sample bearing for each bridge structure in the project plans. Ensure that the sample bearing for each bridge structure is of the same design and materials as the bearings furnished for that bridge structure. The bearing manufacturer will ship the completed sample bearings to an independent testing laboratory for destructive testing for the following physical properties:

Hardness, Durometer A	ASTM D2240
Tensile Strength	ASTM D412
Elongation at Break	ASTM D412
Adhesion bond made during vulcanization	ASTM D429, Method B

Ensure that the bearing manufacturer submits to the project the certified test data for the sample bearings from the independent testing laboratory with the bearing manufacturer's certified test data for the elastomer, base plate, steel laminates, and proof load.

711.24 Waterproofing Fabric. Furnish waterproofing fabric according to ASTM D 173.

Furnish materials according to the Department's QPL.

711.25 Type 2 Membrane Waterproofing.

Physical Properties	
Thickness ASTM D 1777	60 mils (1500 μm) min.
Width	36 inches (914 mm) min.
Pliability [180° bend over 1/4 inch (6 mm) mandrel @ -25 °F (-32 °C)] ASTM D 146	No Effect
Elongation ASTM D 412 (Die C)	300% min
Puncture Resistance-Membrane ASTM E 154	40 lb (18 kg) min.
Permeance (Grains/ft^2/hr/in Hg) ASTM E 96, Method B	0.1 max.
Water Absorption (% by Weight) ASTM D 570	0.2 max.
Adhesion to concrete ASTM D 903	5.0 min.

Submit certified test data and letter of certification to the Engineer.

Furnish materials according to the Department's QPL.

711.26 Structural Timber, Lumber and Piling. Furnish structural timber, lumber and piling according to 712.06, and AASHTO M 168, with the following modification:

Air-dry or kiln-dry timber and lumber to a moisture content not to exceed 19 percent by weight. Size and grade will conform to American Lumber Standards.

Use only structural timber, lumber, and piling meeting the certification requirements of Supplement 1072.

711.27 Prestressing Steel Strands. Furnish prestressing steel strands according to ASTM A 416, with the following modification:

11 Sample and inspect as directed by the Laboratory.

711.28 Cellular Polyvinyl Chloride Sponge. Furnish cellular PVC sponge according to AASHTO M 153, Type I, and with a minimum density of 20 pounds per cubic foot (320 kg/m^3).

Furnish materials according to the Department's QPL.

711.29 Type 3 Membrane Waterproofing. Furnish Type 3 membrane waterproofing conforming to the following requirements.

Physical Properties	
Thickness	0.135 inches (3.43 mm) min.
Width	36 inches (914 mm) min.
Weight	0.8 lb/ft2 (3.875 kg/mm^2) min.
Tensile strength (machine direction) ASTM D 882 Modified [1]	275 lb/in (48.1 N/mm) 200 psi (13.8 MPa)
Tensile strength ASTM D 882 (90° machine direction) Modified [1]	150 lb/in (26.2 N/mm) 1000 psi (6.9 MPa)
Elongation at break ASTM D 882, Modified [1]	100%
Brittleness ASTM D 517	Pass
Softening point (mastic) ASTM D 36	200 °F (93 °C) min.
Peel adhesion ASTM D 413 [1]	2.0 lb/in (0.35 N/mm)
Cold flex ASTM D 146 2 × 5 inch (50 × 125 mm) specimen-180° bend over 2 inch (50 mm) mandrel	No cracking
Heat stability 2 × 5 inch (50 × 125 mm) specimen vertically suspended in a mechanical convection oven 2 hr @ 190 °F (88 °C)	No dripping or delamination

[1] 12 inches (300 mm)/minute test speed and 1 inch (25 mm) initial distance between the grips.

Submit certified test data and letter of certification to the Engineer.

Furnish materials according to the Department's QPL.

711.30 Aluminum for Steps. Furnish aluminum for steps according to ASTM B 221 (ASTM B 221M), Alloys 6061-T6 or 6005-T5.

Furnish materials according to the Department's QPL.

711.31 Reinforced Propylene Plastic Manhole Steps. Furnish reinforced propylene plastic manhole steps conforming to the details shown on the plans.

Furnish steel rod according to 709.01, Grade 60 that is continuous through the entire length of legs and tread. The steel may be coated according to ASTM A 934/A 934M. Ensure that the manufacturer furnishes written certification. Furnish propylene plastic according to ASTM D 4101, Table B 33430. Ensure that the manufacturer furnishes certified test data for the propylene plastic used in each lot of steps.

Furnish materials according to the Department's QPL.

712 MISCELLANEOUS

712.01 Expansion Shield Anchors. Furnish anchors conforming to the dimension requirements of the project plans and the following:

A. Type A. Federal Specification A-A-1923A, and A-A-55614.

B. Type B. Federal Specification A-A-1924A.

The supplier or producer of the anchors will provide a certification showing certified test results of the proof load required in the Federal Specifications.

Furnish materials according to the Department's QPL.

712.02 Calcium Chloride. Furnish calcium chloride according to ASTM D 98.

712.03 Sodium Chloride. Furnish sodium chloride according to ASTM D 632, Type I, Grade 1, with the following modification:

4 Total Chlorides (NaCl, $CaCl_2$, and $MgCl_2$ as NaCl based on dry weight) not less than 95 percent.

712.04 Lime and Lime Kiln Dust.

A. Furnish hydrated lime for masonry purposes according to ASTM C 207, Type S.

B. Furnish quick lime for soil stabilization that is certified according to Supplement 1087 and listed on the Department's QPL and according to ASTM C 977, with the following modification:

4.2.1 *Particle size of Quick Lime* – Quick lime shall all pass the 3/8- inch and at least 90 percent shall pass the No. 4 sieve.

C. Furnish lime kiln dust that is certified according to Supplemental 1087. Furnish lime kiln dust that meets the following requirements. Perform chemical analysis of the lime kiln dust according to ASTM C 25.

Combined total calcium oxide and magnesium oxide	50 % minimum
Available calcium hydroxide (rapid sugar test, ASTM C25), plus total MgO content calculated to be equivalent $Ca(OH)_2$	30 % minimum
Loss on ignition (carbon dioxide plus moisture, combined and free on as-received basis)	40 % maximum
Free water (as-received basis)	4 % maximum
Sulfur as SO_3	10 % maximum

Sieve analysis.

Sieve Size	Minimum Percent Passing
No. 4	95
No. 30	90
No. 100	75

Submit test results for the above requirements for every 100 tons of lime kiln dust supplied to the Department. If multiple tests were performed, include the average and standard deviation with the results.

712.06 Preservative Treatment for Structural Timber, Lumber, Piling, Posts, Braces, and Blocks.

A. General. Furnish structural timber, lumber, and pilings according to 711.26, and posts, braces, and blocks according to 710.14, except that moisture may be removed from the untreated lumber at the time of preservative treatment. Ensure that the treatment of structural timber, lumber, piling, posts, and braces conform to the current AWPA standards or AASHTO M-133 and this subsection.

B. Materials. Furnish timber preservatives according to AASHTO M 133 and current AWPA standards.

C. Preparation for Treatment. Sort the material into one kind or designated group of kinds of wood and into pieces of approximately equal size and moisture and sapwood content. Separate material to ensure contact of treating medium with all surfaces.

D. Framing. Conduct all adzing, boring, chamfering, framing, graining, mortising, and surfacing before treatment.

E. Incising. Incise Douglas Fir lumber 3 inches (75 mm) or more thick on all four sides. Incise lumber less than 3 inches (75 mm) thick on the wide faces only, except as shown on the plans.

Incise Douglas fir with a minimum dimension of 2 inches (50 mm) using a suitable power-driven machine before treatment. Southern Yellow Pine is not required to be incised.

Use the spacing and shape of the cutting teeth and the method of incising necessary to produce a uniform penetration. The minimum required depths of the incisions are as follows:

Size[1]		Minimum depth of incision, inch (mm)	
2 × 12	(50×300)	3/8	(9)
3 × 12	(75×300)	7/16	(11)
4 × 12	(100×300)	1/2	(13)
8 × 10	(200×250)	9/16	(14)
10 × 12	(250×300)	5/8	(16)
12 × 12	(300×300)	3/4	(19)

[1] Intermediate size in proportion.

F. Amount of Preservative. Pressure preservative treat all species of structural timber, lumber, piling, posts, and blocks in accordance with the appropriate AWPA U1 Commodity Standard or AASHTO M 133.

G. Acceptance. Accept only structural timber, lumber, piling, posts, braces, and blocks according to Supplement 1072.

H. Sawn Wood Sign Posts. A sawn wood post must adhere to AASHTO M 168: Wood Products standards, and be the allowable grade and species for the sizes shown in the following table:

Nominal post size[a]	Allowable grade and species
4 by 4 inches	No. 1 structural light framing Douglas fir, free of heart center
	No. 1 structural light framing Hem-Fir, free of heart center
	No. 1 structural light framing Southern Yellow pine
4 by 6 inch	No. 2 structural joists & planks Douglas fir, free of heart center
	No. 1 structural joists and planks Hem-Fir, free of heart center
	No. 1 structural joists and planks Southern Yellow pine
Greater than 4 by 6 inches	No. 1 posts and timbers, also known as No. 1 structural Douglas fir, free of heart center
	Select structural Hem-Fir, free of heart center
	No. 1 timbers Southern Yellow pine

[a] Sizes shown are nominal dressed sizes

The sweep must not exceed .08 foot in 10 feet.

Sawn wood sign posts must be graded per the following:

Southern Pine Inspection Bureau (SPIB) Standard Grading Rules
Western Wood Products Association (WWPA) Standard Grading Rules
West Coast Lumber Inspection Bureau (WCLIB) Standard Grading Rules

Posts must be treated per current AASHTO M 133: Preservatives and Pressure Treatment Processes for Timber standards and AWPA U1 Commodity Specification A.

Douglas fir and Hem-Fir posts must be incised prior to treatment.

Inspection shall be in accordance with AWPA M2.

Quality control shall be in accordance with AWPA M3.

Care and field treatment of the posts shall be in accordance with AWPA M4.

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712.09 Geotextile Fabrics. Furnish fabric composed of strong rot-proof polymeric fibers formed into a woven or non-woven fabric. Products must be tested by the National Transportation Product Evaluation Program (NTPEP). The Department will determine acceptance of Type A, B, C and D fabric according to data obtained in the most current NTPEP report – Laboratory Results of Evaluations on Geotextiles and Geosynthetics. The NTPEP testing results must meet or exceed the requirements listed in Table 712.09-1. For all tests except Ultraviolet Exposure, the products Minimum Average Roll Values (MARV), as published in the NTPEP report, must also meet or exceed the requirements listed in the table. If no MARV value is published in the NTPEP report, the manufacturer must submit to the Department certified test data showing the MARV values for the product will meet or exceed the requirements listed in Table 712.09-1.

For Type E material, supply fabric conforming to the requirements of AASHTO M288, Section 10, Table 8. The Department will accept Type E material based on certified test data.

All minimum strengths shown are in the weakest principal direction.

Ensure that the fabric is free of any treatment that might significantly alter its physical properties.

During shipment and storage, wrap the fabric in a heavy-duty protective covering to protect it from UV deterioration, direct sunlight, dirt, dust, and other debris.

Furnish Type A, B, C, and D material according to the Department's Approved List and Supplement 1123.

TABLE 712.09-1

Property	Test Method	Required Value
Type A: Underdrains and Slope Drains		
Minimum tensile strength	ASTM D 4632	80 lb
Minimum puncture strength [1]	ASTM D 6241	140 lb
	or ASTM D 4833	25 lb
Minimum tear strength	ASTM D 4533	25 lb
Apparent opening size	ASTM D 4751	
Soil Type-1: Soils with 50% or less passing No. 200 (75 µm) sieve		AOS ≤ 0.6 mm
Soil Type-2: Soils with 50 to 85% passing No. 200 (75 µm) sieve		AOS ≤ 0.3 mm
Minimum permittivity	ASTM D 4491	0.5 sec^{-1}
Type B: Filter Blankets for Rock Channel Protection		
Minimum tensile strength	ASTM D 4632	200 lb
Minimum elongation	ASTM D 4632	15%
Minimum puncture strength [1]	ASTM D 6241	440 lb
	or ASTM D 4833	80 lb
Minimum tear strength	ASTM D 4533	50 lb
Apparent opening size	ASTM D 4751	AOS ≤ 0.6 mm
Minimum permittivity	ASTM D 4491	0.2 sec^{-1}
Type C: Sediment Fences		
Minimum tensile strength	ASTM D 4632	120 lb
Maximum elongation	ASTM D 4632	50%
Minimum puncture strength [1]	ASTM D 6241	275 lb
	or ASTM D 4833	50 lb
Minimum tear strength	ASTM D 4533	40 lb
Apparent opening size	ASTM D 4751	AOS ≤ 0.84 mm
Minimum permittivity	ASTM D 4491	0.01 sec^{-1}
Ultraviolet exposure strength retention [2]	ASTM D 4355	70%
Type D: Subgrade-Base Separation or Stabilization		
Minimum tensile strength	ASTM D 4632	180 lb
Maximum elongation	ASTM D 4632	50%
Minimum puncture strength [1]	ASTM D 6241	385 lb
	or ASTM D 4833	70 lb
Minimum tear strength	ASTM D 4533	70 lb
Apparent opening size	ASTM D 4751	Same as Type A
Minimum permittivity	ASTM D 4491	0.05 sec^{-1}

[1] ASTM D6241 is now the standard puncture resistance test required by AASHTO and NTPEP. NTPEP will continue to publish product data, tested under ASTM D4833, until the product is retested under ASTM D6241.

[2] Provide certified test data to the Department. Include strength retention data at 0, 150, 300, and 500 hours

712.10 Prefabricated Edge Underdrain. Furnish prefabricated edge underdrain consisting of a polymeric core with a minimum thickness of 1 inch wrapped in fabric according to 712.09, Type A. Ensure that the underdrain is flexible, rectangular in shape, and of hollow construction. Use core material that is resistant to petroleum-based chemicals, naturally occurring soil chemicals, and road de-icing agents. The core material will have sufficient flexibility to withstand bending and handling during installation without damage. The core will provide a minimum of 100 square inches unobstructed (one side only) drainage area per 1 foot of width. Side walls of the core will have at least 5 percent open area to permit unobstructed flow through the filter and wall to the core. The required minimum compressive strength of the prefabricated edge drain is 6000 pounds per square foot with a maximum 20 percent compression in a parallel plate compression test (ASTM D 695). The minimum (single side) core flow capacity is 10 gallons per minute per foot of width for a 0.1 gradient at 10 pounds per square inch bladder load according to ASTM D 4716. Furnish the manufacturer's certified test results as specified 101.03.

712.11 Temporary Erosion Control Mats Materials. Unless specifically itemized, furnish any of the type mats listed below. Provide certified test data for each shipment of material.

A. Type A Temporary Erosion Control Mat. Conform to the following:

1. A machine-produced mat consisting of 100 percent agricultural straw covered on the top with a polypropylene netting having an approximate 1/4 × 1/4 inch to 1/2 × 1/2 inch (6 × 6 mm to 13 × 13 mm) mesh, and sewn together with biodegradable or photodegradable thread.

2. A consistent thickness with the straw evenly distributed over the entire area of the mat.

3. A minimum mat width of 6.5 feet (2 m).

4. An average mat weight of 0.5 pound per square yard (270 g/m^2) ± 10 percent.

5. A netting weight of approximately 1 pound per 1000 square feet (5 kg/1000 m^2).

B. Type B Temporary Erosion Control Mat. Conform to the following:

1. A machine-produced mat consisting of 100 percent agricultural straw covered on the top with a photodegradable polypropylene netting having an approximate 1/2 × 1/2 inch to 5/8 × 5/8 inch (13 × 13 mm to 16 × 16 mm) mesh and on the bottom with a photodegradable polypropylene netting having an approximate 1/4 × 1/4 inch to 1/2 × 1/2 inch (6 × 6 mm to 13 × 13 mm) mesh, sewn together with biodegradable or photodegradable thread.

2. A consistent thickness with the straw evenly distributed over the entire area of the mat.

3. A minimum mat width of 6.5 feet (2 m).

4. An average mat weight of 0.5 pound per square yard (270 g/m^2) ±10 percent.

5. A top netting weight of approximately 3 pounds per 1000 square feet (15 kg/1000 m^2) and a bottom netting weight of approximately 1 pound per 1000 square feet (5 kg/1000 m^2).

C. Type C Temporary Erosion Control Mat. Conform to the following:

1. A machine-produced mat consisting of 70 percent agricultural straw and 30 percent coconut fiber covered on the top with a photodegradable polypropylene netting having an approximate 5/8 × 5/8 inch (16 × 16 mm) mesh and on the bottom with a photodegradable polypropylene netting having an approximate 1/4 × 1/4 inch (6 × 6 mm) mesh, sewn together with cotton thread.

2. A consistent thickness with the straw and coconut fiber evenly distributed over the entire area of the mat.

3. A minimum mat width of 6.5 feet (2 m).

4. An average mat weight of 0.5 pound per square yard (270 g/m^2) ± 10 percent.

5. A top netting weight of approximately 3 pounds per 1000 square feet (15 kg/1000 m^2) and a bottom netting weight of approximately 1 pound per 1000 square feet (5 kg/1000 m^2).

E. Type E Temporary Erosion Control Mat. Conform to the following:

1. A machine-produced mat consisting of 100 percent coconut fiber covered on the top and bottom with an ultraviolet stabilized polypropylene netting having an approximate 5/8 × 5/8 inch (16 × 16 mm) mesh, and sewn together with polyester thread.

2. A consistent thickness with the coconut fiber evenly distributed over the entire area of the mat.

3. A minimum mat width of 6.5 feet (2 m).

4. An average mat weight of 0.5 pound per square yard (270 g/m^2) ± 10 percent.

5. An ultraviolet stabilized polypropylene netting with a weight of approximately 3 pounds per 1000 square feet (15 kg/1000 m^2).

F. Type F Temporary Erosion Control Mat. Conform to the following:

1. A uniform open plain weave of undyed and unbleached single jute yarn.

2. Loosely twisted yarn not varying in thickness by more than one-half its normal diameter.

3. Furnish mats in rolled strips with:

   a. A minimum length of 50 yards (46 m).

   b. A width of 48 inches ± 1 inch (1.2 m ± 25 mm).

c. Warp ends width 81 ± 3.

d. Weft ends per yard (meter) 41 ± 3 (49 ± 3).

e. An average weight of 1.22 pounds per linear yard (0.6 kg/m) ± 10 percent.

G. Type G Temporary Erosion Control Mat. Conform to the following:

1. A machine-produced mat consisting of wood excelsior, 80 percent of which is at least 8 inches (200 mm) in length.

2. Excelsior cut from wood that is properly cured to achieve adequately curled and barbed fibers.

3. A consistent thickness with the fiber evenly distributed over the entire area of the mat.

4. For use in ditches or channels, cover the top and bottom of the excelsior with lightweight netting entwined with the excelsior for maximum strength and ease of handling, or cover the top only with heavyweight netting machine sewn on maximum 2 to 4-inch (51 to 102 mm) centers along the longitudinal axis of the material. For all other applications, cover the top with lightweight netting entwined with the excelsior for maximum strength and ease of handling.

5. Regardless of application, lightweight netting consists of either netting having a maximum 3 × 1 inch (75 × 25 mm) weave, twisted craft [check spelling] paper yarn having a high web strength or biodegradable plastic.

6. Mat widths of 24, 36, 48, or 78 inches (0.6, 0.9, 1.2, or 2 m) or greater, ±1 inch (±25 mm).

7. Mat rolls of more than 90 feet (27.5 m) in length.

8. A mat weight of not less than 0.72 pound per square yard (390 g/m^2) constant weight, air dry.

I. Type I Temporary Erosion Control Mat. Conform to the following:

1. Extruded polymeric plastic net having a mesh opening of approximately 3/4 × 3/4 inch (20 × 20 mm).

2. A netting with an average weight of 3 pounds per 1000 square feet (15 kg/1000 m^2) ± 10 percent and a minimum tensile strength of 15 pounds over a 3-inch width (67 N over a 77 mm width) in the weakest principal direction.

712.12 Tied Concrete Block Mat. Furnish materials tested according to ASTM D6460 with a minimum un-vegetated shear stress value of 12 psf with Type 1 Underlayment. The Department will determine acceptance based on independent third-party test data. Furnish materials with the following underlayment options:

Type 1 Underlayment: Temporary Erosion Control Mat

Type 2 Underlayment: Temporary Erosion Control Mat and Turf Reinforcing Mat

Furnish products according to the Departments QPL.

712.13 Articulating Concrete Block Revetment System. Furnish materials according to ASTM D6684 and tested according to ASTM D7277. The Department will determine acceptance of Type 1, 2, 3 based on independent third party test data. The acceptable stability threshold shear values are:

Type 1: 17 lbf/ft² (810 Pa)

Type 2: 20 lbf/ft² (960 Pa)

Type 3: 23 lbf/ft² (1100 Pa)

Furnish products according to the Department's QPL.

712.14 Detectable Warning Devices Furnish materials conforming to the following requirements:

Products must be compliant with AASHTO M333.

Products will be designed to be physically embedded into concrete and be of a color that visually contrasts with the concrete. Do not use black as a color.

Products may be manufactured from materials of cast iron, stainless steel, polymer concrete, reinforced polymer composite, or granite. Products may be designed as either one time installation products or replaceable products.

Surface applied, stamped concrete, concrete, and brick products will not be permitted.

Detectable Warning Devices will be provided with a minimum 5 year written warranty with at least the following:

1. The installed device will remain AASHTO M333. compliant for the term of the warranty period.
2. During the warranty period at least 85% of the truncated domes on installed device will remain entirely intact.
3. The installed device will remain securely affixed to and flush with the concrete substrate.
4. Any surface coating applied to the installed product will remain in place and color fast.
5. At no cost to the Department, the manufacturer will replace the product, including all installation costs, if during the 5 year warranty period the product fails to comply with the above warranty requirements. Any new device installed under the warranty will meet the requirements of this specification

As part of the Department Acceptance process for inclusion on the Approved List submit the proposed warranty to the Department along with material samples, dimensional drawings, and written installation procedures.

Upon acceptance by the Department the materials will be listed on the Department's Approved List.

Furnish materials according to the Department's Approved List.

Begin warranty period upon Contract acceptance.

At the preconstruction meeting provide the Engineer with the written warranty signed by the executive officer of the manufacturing company.

712.15 Geogrid. Furnish biaxial geogrid consisting of punched and drawn polypropylene. Furnish geogrid which is dimensionally stable and able to retain its geometry under construction stresses. Furnish geogrid that is resistant to damage during construction, ultraviolet degradation, and all forms of chemical and biological degradation encountered in the soil on which it is placed. Furnish geogrid that conforms to the properties presented in Table 712.15-1. Furnish geogrid according to the Department's Qualified Products List.

TABLE 712.15-1 REQUIRED GEOGRID PROPERTIES

Property	Test Method	Required Value[1]
Reinforcement Properties		
Strength at 2% Strain	ASTM D 6637	400 lb/ft
Minimum Opening Size	Direct Measure	0.75 in [2]
Maximum Opening Size	Direct Measure	3.0 in [3]
Survivability Index Values		
Ultimate Tensile Strength	ASTM D 6637	1300 lb/ft
Junction Strength	GRI[4] GG2	130 lb
Ultraviolet Stability	ASTM D 4355	70 % at 500 hrs

[1] Values, except ultraviolet stability, are Minimum Average Roll Values (MARV), i.e., average value minus two standard deviations). Strength in the machine and cross-machine directions must both meet the required value.

[2] Minimum opening size must be $\geq D_{50}$ of aggregate above geogrid to provide interlock.

[3] Maximum opening size must be $\leq 2 \times D_{85}$ to prevent aggregate from penetrating into the subgrade.

[4] GRI – Geosynthetic Research Institute

Follow ASTM D 4873 for geogrid labeling, shipment, and storage. Furnish product labels that clearly show the manufacturer's or supplier's name, product type, lot number, roll number, manufactured date, and roll dimension. Furnish a notation for each shipping document certifying that the material is in accordance with the manufacturer's certificate.

During shipment and storage, protect the geogrid from direct sunlight, UV deterioration, temperatures greater than 160 ºF, flames including welding sparks, mud, dirt, dust, and debris. Keep the geogrid dry during storage and do not store directly on the ground.

712.16 Prefabricated Geocomposite Drain (PGD). Furnish Prefabricated Geocomposite Drain (PGD) consisting of a drainage core with geotextile fabric bonded to one side. Use drainage core material consisting of a preformed, stable, polymer plastic material with a cusped or geonet structure. Use drainage core that supports the geotextile and provides a bonding surface for the geotextile at intervals not exceeding 1-1/8 inches (29 mm) in any direction. Supply core that provides at least 14 square inches per square foot of flat area in contact with the geotextile.

Furnish a geotextile fabric composed of over 85% of polyester, polypropylene, polyolefin, or polyamide fibers by weight, that are formed into a stable network to ensure the performance during handling, installation, and service life. Use geotextile fabric that is resistant to chemical attack, rot, and mildew. Use geotextile fabric that is free of treatments or coatings that would adversely change the hydraulic properties

of geotextile after installation. Furnish PGD that has the geotextile fabric covering the full length of the drainage core and has minimum 3 inch (76 mm) wide flaps/flanges of fabric extending beyond both longitudinal edges of the drainage core. Do not supply PGD that has ripped or torn geotextile fabric.

Furnish PGD in rolls, or in another acceptable manner, wrapped with an opaque, waterproof wrapping. Label or tag each roll or package to provide product identification sufficient to determine the product type, manufacturer, quantity, lot number, roll number, and date of manufacture. Prior to installation, protect the PGD from mud, dirt, dust, debris, harmful ultraviolet light, direct sunlight or temperature greater than 140 ˚F (60 ℃). Furnish 3 inch (76 mm) wide, plastic tape for the sealing, seaming, and splicing the PGD. Furnish waterproof tape designed for underground applications that provides a strong bond that does not deteriorate over time in a buried condition. Furnish fittings and accessories provided by the manufacturer if available.

Submit Certified Test Data showing the product will meet or exceed the requirements listed in Tables 712.16-1 and 712.16-2.

TABLE 712.16-1

REQUIRED PGD CORE PROPERTIES

Property	Test Method	Unit	Required Value		
			Conventional Abutment/Wall Height		
			<10 ft (3m)	10 to 30 ft (3 to 9m)	30 to 50 ft (9 to 15m)
Thickness	ASTM D5199	in (mm)	0.4 to 1.0 (10 to 25)		
Minimum Compressive Strength	ASTM D1621	psf (kPa)	4625 (221)	10625 (508)	16625 (796)
Minimum In-Plane Flow Rate*	ASTM D4716	gal/min/ft (l/min/m)	5 (62)	15 (186)	25 (310)

* Tested under a confining pressure of 3,600 psf (172 kPa) and a hydraulic gradient of 1.0.

TABLE 712.16-2

REQUIRED PGD GEOTEXTILE PROPERTIES

Property	Test Method	Unit	Required Value		
			Percent *In Situ* Soil Passing 0.075 mm		
			<15	15 to 50	>50
Minimum Permittivity	ASTM D 4491	sec^{-1}	0.5	0.2	0.1
Apparent Opening Size	ASTM D 4751	mm	AOS ≤ 0.43	AOS ≤ 0.25	AOS ≤ 0.22
Minimum Grab Strength	ASTM D 4632	lb (N)	157 (700)		
Maximum Elongation	ASTM D 4632	%	50		
Minimum Trapezoidal Tear Strength	ASTM D 4533	lb (N)	56 (250)		
Minimum Puncture Strength	ASTM D 6241	lb (N)	309 (1375)		
	or ASTM D 4833	lb (N)	58 (260)		

720 DELINEATOR MATERIALS

720.01 Reflectors. For bridge parapet bracket or bridge rail bracket, furnish rectangular reflectors that are a minimum size of 3 × 6 inches (75 × 150 mm) and that consist of reflective sheeting according to 730.192 or 730.193 adhered to an aluminum plate. Furnish white, yellow, or red reflectors as specified. Furnish aluminum plate for reflectors according to ASTM B 209 (B 209M), 6061-T6 with a minimum thickness of 0.060 inch (1.5 mm).

For ground mounted delineators, furnish rectangular reflective sheeting according to 730.192 or 730.193 that is a minimum size of 3 × 6 inches (75 × 150 mm) adhered to a flexible post. Furnish white, yellow or red reflectors as specified.

For surface mounted delineators, furnish a 3-inch (75 mm) wide band of reflective sheeting according to 730.192 or 730.193 adhered completely around a flexible post. Furnish white or yellow reflectors as specified.

Furnish materials according to the Department's QPL.

720.03 Flexible Posts. Conform to Supplement 1020.

Furnish materials according to the Department's QPL.

721 RAISED PAVEMENT MARKER MATERIALS

721.01 Raised Pavement Marker Castings. Furnish castings conforming to Supplement 1062. Ensure that the casting is nodular iron according to ASTM A 536, hardened to 51-55 RC, snow plowable in the two opposing longitudinal directions and designed to accommodate a replacement prismatic retroreflector.

Furnish materials according to the Department's QPL.

721.02 Prismatic Retroreflector and Adhesive. Furnish prismatic retroreflectors conforming to Supplement 1062. Furnish reflectors that contain one or two prismatic reflective faces to reflect incident light from a single or opposite directions. Furnish reflectors with nominal dimensions of 4 × 2 × 0.48 inch (100 × 50 × 12 mm). Ensure that the reflector fits securely in the recessed area and does not protrude above the profile of the casting.

Furnish manufacturer recommended retroreflector adhesive to bond the prismatic retroreflectors to casting.

Furnish materials according to the Department's QPL.

721.03 Casting Adhesive. Furnish casting adhesives that conform to Supplement 1062.07 - Raised Pavement Marker Casting Adhesive Acceptance Procedure.

Only furnish material listed on the Department's QPL.

725 HIGHWAY LIGHTING MATERIALS

725.01 General. Furnish luminaires, conduits, wire, switch gear and other electrical hardware that are listed with Underwriters Laboratories.

Ensure that each item of manufactured electrical apparatus as a unit has a durable nameplate identifying the manufacturer and manufacturer's product identification.

Only provide samples when required by the Laboratory.

725.02 Wire and Cable. Ensure that each nonshielded wire or cable rated 0-2kV is single conductor, stranded copper with cross-linked thermosetting polyethylene insulation, nonjacketed, meets the requirements of ICEA S-95-658/NEMA WC70 and is of UL Type RHH-RHW-USE except for conductors 10 AWG and smaller for which those with insulation meeting the requirements of UL Type XHHW may also be used.

Ensure that each non-shielded wire or cable rated 2400 volts is single conductor, stranded copper with chemically cross-linked polyethylene insulation, nonjacketed, meets the requirements of ICEA S-96-659/NEMA WC71 and of UL Type MV-90 dry.

Ensure that each cable's identification device defining its use is either a tag tied onto the cable or a band applied around the cable. Ensure that cable tags are of copper, brass or plastic (except for tags within switch and device cabinets which shall be nonconducting) 1/32 inch (0.8 mm) minimum in thickness permanently fastened to the cables by means of cable tying straps. Ensure that cable identifying

bands are approximately 1/32 inch (0.8 mm) thick wrap completely around the cable and closed securely. Ensure that each tag or band is marked using 1/4 inch (6 mm) minimum height embossed or engraved letters.

Ensure that conductors shall be marked "CKT" followed by the circuit designation shown on the plans and that grounding conductors are marked "GND" and that neutral conductors are marked "NEU" and that hot conductors are marked "Line" followed by "1" or "2" for single phase power or "Phase" followed by "A" or "B" or "C" for three phase power.

Furnish materials according to the Department's QPL.

725.03 Unit Type Duct-Cable Systems Ensure that factory made cable-in-duct has conductors as specified, that the duct is high density polyethylene Type III, Class C, Category 5, Grade 34 conforming to NEMA TC-7 and that the duct has the manufacturer's name and the year of manufacture included in the marking.

Conductors and neutrals will conform to 725.02.

Furnish materials according to the Department's QPL.

725.04 Rigid Galvanized Steel Conduit and Fittings Ensure that rigid galvanized steel conduit complies with the requirements of ANSI C 80.1 and UL 6 Type I and that each length of conduit bears the UL label. Furnish fittings that comply with the requirements of ANSI/NEMA FB 1 AND ANSI/UL 514B.

Furnish materials according to the Department's QPL.

725.051 Polyvinyl Chloride Conduits and Fittings. Furnish polyvinyl chloride conduit EPC-40-PVC conforming with NEMA Standard TC 2 for normal above ground or below ground installation, either concrete encased or direct burial. Use fittings conforming to NEMA Standard TC-2 references.

Furnish materials according to the Department's QPL.

725.052 Polyethylene Conduits and Fittings. Furnish polyethylene conduit EPEC-40-HDPE conforming to NEMA Standard TC 7 for below ground only installation, whether concrete encased or direct burial. Use fittings conforming to ASTM D3350.

Furnish materials according to the Department's QPL.

725.06 Polymer Concrete Pull Boxes Ensure that the polymer concrete pull box and cover is of aggregate bound with a polymer resin. Ensure that the body of the box is of one piece construction. Ensure that all surfaces of the box and cover are smooth and that the cover has a molded slip resistant surface. Ensure that the cover is slip resistant and is labeled in clearly legible block letters 1 to 2 inches (25 to 50 mm) in height integral to the cover with the word "TRAFFIC", "LIGHTING", "ELECTRIC" or "COMM" to designate the circuit(s) contained. Ensure that the cover closely fits the opening and is secured by stainless steel bolts (hex head unless penta head is specified in the plans) and hardware and that the threaded holes into which the cover bolts fasten are of open bottom design. Ensure that the box and cover meet the structural requirements of ANSI/SCTE 77-2002 "Specification for Underground Enclosure Integrity" Tier 15, including lateral loading requirements.

The load rating of the box shall be permanently denoted on the top surface of the cover. The temperature range of the cover shall be at least -30°C to +80°C.

The pull box cover shall be polymer concrete.

Furnish materials according to the Department's QPL.

725.07 Plastic Pull Boxes Ensure that the plastic pull box and cover is of high density ultraviolet stabilized molded polymer or structural foam. The box depth may be obtained through the use of extensions or stacking.

Ensure that the cover is slip resistant and is labeled in clearly legible block letters 1 to 2 inches (25 to 50 mm) in height integral to the cover with the word "TRAFFIC", "LIGHTING", "ELECTRIC" or "COMM" to designate the circuit(s) contained. Ensure that the cover closely fits the opening and is secured by stainless steel bolts (hex head unless penta head is specified in the plans) and hardware and that the threaded holes into which the cover bolts fasten are of open bottom design. Ensure that the box and cover meet the structural requirements of ANSI/SCTE 77-2002 "Speicifcation for Underground Enclosure Integrity" Tier 15, including lateral loading requirements. The load rating of the box shall be permanently denoted on the top surface of the cover. The temperature range of the cover shall be at least -30°C to +80°C.

The pull box cover shall be polymer concrete.

Furnish materials according to the Department's QPL.

725.08 Portland Concrete Pull Boxes.

A. Pull Box. Ensure that the Portland concrete pull box is constructed of reinforced portland cement concrete. When the box is precast, provide pull boxes from suppliers certified to Supplement 1073. Ensure that the pull box cover is constructed according to 725.08B and as shown on the plans. Equip the pull box with a stainless steel electrical grounding stud, 1/4-20 UNC thread, with 1/2-inch minimum stickout, located in the lower third of an interior wall.

B. Pull Box Covers. Furnish metal pull box covers that conform to the following requirements:

1. Furnish 1/2-inch (13 mm) thick steel plate for the steel cover conforming to 711.01 with a 1/2-inch (13 mm) minimum flange around the edge and galvanized to conform to 711.02. Display on the steel cover or on an attached brass or stainless steel plate (tag) clearly legible block letters 1 to 2 inches (25 to 50 mm) in height with the word "TRAFFIC", "LIGHTING", "ELECTRIC" or "COMM" to designate the circuit(s) contained. Ensure that the word designating the use is in raised letters that are either integral to the steel cover or integral to a brass or stainless steel plate 1/16 inch (1.6 mm) in thickness securely mechanically attached to the steel cover at the four corners of the tag and at intervals 2 to 3 inches (50 to 75 mm) along the perimeter between corners.

2. Furnish gray iron or ductile iron with a minimum thickness of 3/8 inch (9 mm) conforming to 711.14. Certification is required. Ensure that the word "TRAFFIC," "LIGHTING", "ELECTRIC," or "COMM" is cast in the top surface of the cover forming letters 1 to 2 inches (25 to 50 mm) in height.

725.10 Junction Boxes. Ensure that the junction boxes are iron castings hot-dip galvanized in accordance with 711.02. Ensure that the junction boxes meet the requirements of NEMA ICS-6-Type 3. When a drilled and tapped conduit entry is stipulated, ensure that the junction box has adequate wall thickness and that a boss has been cast into the box if necessary.

Furnish materials according to the Department's QPL.

725.11 Luminaires

A. Optical System. Furnish a luminaire set to the photometric distribution stipulated in the plan and that the distribution along with the settings required to produce it are clearly indicated on a durable label affixed to the interior of the housing in a position readily apparent and easily read by a worker lamping the luminaire.

Furnish a luminaire with a borosilicate glass refractor free of striations and imperfections and embossed to clearly indicate the street side when the refractor may be installed in more than one position. Ensure the refractor is held firmly in the housing, but is easily removed without the use of special tools.

Furnish a luminaire with an aluminum reflector with a specular polished reflective surface free from scratches. Ensure the reflector is held firmly in the housing, but is easily removed without the use of special tools.

Furnish a luminaire with a socket for mogul base lamps where there is a choice of size for the application at hand.

Furnish a lamp socket with a large center contact spring providing a firm contact with the lamp base and lamp grips to prevent the lamp from loosening. Ensure that the shell is shrouded in porcelain and that the wiring terminals and contacts are identified.

Ensure that socket position adjustments have positive indexing such as holes, lugs or notches and are not slots with infinite settings.

Ensure that socket adaptors are not necessary and not used.

B. Lamps. Furnish a luminaire that has been provided with a lamp of the type and wattage specified and that each lamp has a clear glass envelope, a date recording feature and does not have any ballasting or starting components.

Furnish high pressure sodium lamps that are first line, high quality lamps having heat resistant clear glass envelopes with a quartz arc tube interior with horizontal initial lumens and approximate hours of life not be less than the values shown in Table 725.11-1.

TABLE 725.11-1

ANSI	WATTS	Horizontal Lumens Initial	Economic Life Hours
S62	70	5,800	14,000
S54	100	9,500	14,000
S55	150	16,000	16,000
S66	200	22,000	16,000
S50	250	27,500	16,000
S67	310	37,000	16,000
S51	400	50,000	16,000
S52	1,000	130,000	16,000

Furnish high pressure sodium lamps that produce a minimum of 80 percent of the initial lumen output at the end of economic life.

C. Ballast. Ensure that the ballast is of an integral design contained within the luminaire housing.

If the ballast is to be wired line to line or phase to phase, ensure that the ballast has an isolated primary winding.

Furnish a ballast (in conjunction with the starter in the case of high pressure sodium lamps) capable of starting and operating the lamp at ambient temperatures as low as -20 °F (-30 °C).

At circuit voltage of nominal plus or minus 10 percent or the ballast manufacturer's stated range if greater, ensure that the ballast can start (in conjunction with the starter in the case of high pressure sodium lamps) and operate the lamp within the lamp's ANSI operating parameters for the full design life of the lamp.

Furnish a ballast capable of operation with the lamp in an open or short circuit condition for six months without significant loss of ballast life.

Furnish a starter of encapsulated solid state design capable of withstanding the temperatures encountered in the ballast compartment of the luminaire.

Ensure that the starter provides a timed pulsing with sufficient follow through current to completely ionize and start all lamps that meet published ANSI standards.

Ensure that the starter has push-on type electrical terminations and is field replaceable with no adjustment necessary for proper operation.

Ensure that there is a barrier type terminal block for connection of the incoming electrical circuit.

D. Housing. Furnish a housing of cast aluminum.

Ensure that the housing has a flat area on the top side on which a level may be placed and read by a worker leveling a mounted luminaire on an erected support.

Ensure that the door(s) providing access to the optical and electrical components have hinges and latches of corrosion resistant materials that remain securely closed during operation.

Ensure that the silicone rubber, ethylene propylene terpolymer, dacron felt or other durable gaskets and seals supplied by the manufacturer either as part of the basic luminaire or as options are in good condition and properly installed at the socket entry, between the refractor and reflector and any other location where such gaskets or shields are part of the luminaire and options.

Ensure that the exterior finish of the luminaire is a light gray color unless otherwise specified.

Furnish a glare shield of aluminum or opaque plastic material when specified. Furnish a shield supplied by the manufacturer of the luminaire.

E. Conventional Luminaries. Ensure that the luminaire housing doors may be opened, closed, removed or installed without the use of tools.

Ensure that the clamp for the slip-fit mounting accommodates both 1 1/4 inch (32 mm) and 2 inch (50 mm) nominal pipe mounting bracket. Ensure that a stop is provided as part of the housing to prevent over insertion of the bracket into the housing. Ensure that the clamp engages at least 4 1/2 inches (115 mm) longitudinally along the arm of the bracket arm between the extremes of a minimum of two clamping points. Ensure that the mounting clamp provides for leveling of the luminaire to the specified transverse and longitudinal position with respect to the roadway.

Ensure that the luminaire is equipped with a device indicating the direction and amount of tilt over a range of zero to five degrees in any direction with indications at level, three degree tilt and five degree tilt all accurate to one half degree. Ensure that the indicating device is clearly readable in daylight from a distance of 50 feet (15 m) and in no way alters or reduces the amount of light from the luminaire. Ensure that the indicating device is constructed of a transparent container having one horizontal surface which is curvilinear in any vertical cross section for supporting an indicator and a damping fluid. Ensure that the damping fluid is a liquid which shall be suitable for operation at -40 °F (-40 °C) and that the transparent container is fabricated from clear ultraviolet-inhibited acrylic or similar material.

Ensure that the glare shield will cut off the upward component of light and that it does not reduce the total output of the luminaire more than 3 percent.

Ensure that the luminaire has a label or decal indicating the type of source and wattage rating. Ensure that, with the luminaire installed in its normal operating position, the label or decal is clearly legible in daylight at a distance of 50 feet (15 m). Ensure that the labeling is in accordance with the provisions of NEMA Publication OD-150 or EEI Publication TDJ-150.

Ensure that the complete conventional luminaire assembly including the lamp and all options including, when required, the glare shield does not weigh more than 75 pounds (34 kg).

F. Wall Mounted Underpass Luminaires. Ensure that the assembly is weatherproof and sealed against dust.

Ensure that a wire entry for the incoming power is provided on both of the vertical side surfaces of the housing, that each entry is drilled and tapped for 3/4-inch (19 mm) conduit and that the unused entry is properly closed with the screw type plug supplied by the manufacturer.

Ensure that the luminaire housing doors may be opened, closed, removed or installed without the use of special tools.

Ensure that the housing can be mounted onto a vertical flat surface by means of cap screws or bolts through the wall side of the housing.

For mounting on concrete, use adhesive-grip anchors designed to be set into a drilled hole half-filled with material meeting 705.20, with a minimum hole depth of 1-3/4 inches.

Ensure that the luminaire has the option for protecting the glass refractor with a guard or shield that is integral to the luminaire and does not have to be removed to gain access to the lamp or ballast.

G. High Mast / Low Mast Luminaires. Ensure that luminaires with a symmetric distribution shall have an initial intensity of no more than 100 candela per 1000 lamp lumens at nadir and no more than 325 candela per 1000 lamp lumens at angles between 55 and 65 degrees above nadir.

Ensure that luminaires with an asymmetric distribution or a long and narrow distribution shall have an initial intensity of no more than 175 candela per 1000 lamp lumens at nadir and no more than 425 candela per 1000 lamp lumens at angles from 66 through 73 degrees above nadir.

Ensure that the output efficiency of the luminaire shall be not less than 65 percent of the bare lamp lumens. The luminaire shall emit at least 25 percent but no more than 35 percent of the bare lamp lumens at vertical angles of at least 60 degrees above nadir but no more than 90 degrees above nadir.

Ensure that no portion of the arc tube of the lamp shall be viewable at angles of 70 degrees or more above nadir.

Ensure that the photometric distribution is produced by an optical assembly consisting of a reflector alone or in combination with a refractor which redirects the output of a lamp mounted in a socket therein and that the reflector and refractor (if used) are each of a one piece design.

Ensure that the optical assembly is field rotatable to align the light distribution horizontally independent of the orientation of the arm supporting the luminaire.

Ensure that a luminaire for use with a 1000 watt lamp has an auxiliary lamp support that engages the outer end of the lamp envelope.

Ensure that the luminaire is of substantial design adequate to operate at mounting heights up to and including 150 feet (45 m) and wind velocities up to and including 90 mph (145 km/h).

Ensure that the luminaire mounts by means of a slip fit onto a horizontal 2-inch (50 mm) pipe and that the luminaire's integral mounting provides adjustment

for leveling but remains secure and does not twist about the mounting pipe of the bracket when subjected to the vibration and wind loads of the installation.

Ensure that the maximum weight of the complete luminaire does not exceed 75 pounds (34 kg) and the maximum projected area does not exceed 3.5 square feet (0.3 m^2).

725.12 Polyethylene, Fiberglass Reinforced, Pull Box with Polymer Concrete Cover and Support Ring Ensure that the pull box body is of fiberglass reinforced high density ultraviolet stabilized molded polyethylene with a polymer concrete cover support ring and polymer concrete cover. Ensure that the body of the box is of one piece construction. Ensure that the body of the box has a wall thickness of at least 1/4 inch (6 mm). Ensure that the cover support ring is permanently integrated into the box. Ensure that the cover is slip resistant and has in clearly legible block letters 1 to 2 inches (25 to 50 mm) in height integral to the cover the word "TRAFFIC", "LIGHTING", "ELECTRIC" or "COMM" to designate the circuit(s) contained. Ensure that the cover closely fits the opening and is secured by stainless steel bolts and hardware and that the threaded holes into which the cover bolts fasten are of open bottom design. Ensure that the box and cover meet the structural requirements of Society of Cable Telecommunications Engineers Tier 5.

Furnish materials according to the Department's QPL.

725.15 Circuit Cable Connections and Terminations. Ensure that each connector or terminator is of the same voltage rating as the wire being connected or terminated except that 600 volt connectors may be used with 5000 volt (secondary service) cable used in 600 volt service for the highway lighting circuits.

Ensure that each connector or terminator is a compression style which fully encloses the conductor(s) and is of high strength copper alloy not a metal other than copper which has been plated. Ensure that each connector used for a "butt" splice is a sleeve type with a "stop" in the center.

A. Termination of Oversize Wire. Ensure that each cable terminal of each device can properly accommodate the size of the wire being terminated. If a terminal of adequate size cannot be furnished, ensure that a short length of smaller wire is connected to the oversize conductor through the use of a proper butt style crimp connector or a terminal block, that no strands have been cut back in the oversize conductor to make the connection and that the smaller wire is rated to carry the full ampacity of the circuit protection device.

B. Fused Pull-Apart Connection. Ensure that each fused pull-apart cable connector kit is a molded synthetic rubber housing consisting of a female line side with two ports and a male load side with one port containing a socket type fuse holder wherein the fuse also acts as the pin for the load connection which is designed to break the circuit when the two halves of the connector body are separated. Ensure that the assembled kit is rated for direct burial and exposure to sunlight. Ensure that the metal parts of connector are of copper with a conductivity of 90 percent, have individual compression connections for each wire on the line side, have a crimp connection for the wire on the load side and have annular spring on the socket for each end of the fuse. Ensure that the fuse holder is for a standard midget 13/32 × 1

-1/2-inch (10 × 38 mm) fuse. Ensure that the fuse is rated 600 VAC, 100,000 AIC and does not have a glass body. Ensure that each cable port is sized for the wire or cable entering the entering the port and that there is a closure for the second line port if it is not to be used.

C. Unfused Pull-Apart Connection. Ensure that each unfused pull-apart cable connector kit is a molded synthetic rubber housing consisting of a female line side with two ports and a male load side with one port containing a line side socket and load side pin making a connection which is designed to break the circuit when the two halves of the connector body are separated. Ensure that the assembled kit is rated for direct burial and exposure to sunlight. Ensure that the metal parts of connector are of copper with a conductivity of 90 percent, have an individual compression connection for each wire on the line side, have a crimp connection for the wire on the load side, and have an annular spring on the socket for the pin. Ensure that each cable port is sized for the wire or cable entering the port and that there is a closure for the second line port if it is not to be used.

D. Unfused Bolted Connection. Ensure that each unfused re-enterable cable connector kit is a rigid molded plastic sleeve closed on each end by a molded synthetic rubber female end housing having one or two ports as needed containing space in which the connection is made by crimping a lug onto each wire and then bolting all of the lugs together. Ensure that the assembled kit is rated for direct burial and exposure to sunlight. Ensure that the metal parts of connector are of copper with a conductivity of 90 percent and that each connecting bolt has a self-locking nut. Ensure that each wire enters through a port sized for the wire and that there is a closure for the port if it is not to be used.

E. Unfused Permanent Connection. Ensure that each cable splicing kit is a rigid transparent molded body having as many as two ports on each which allows the completed splice to be completely encapsulated by filling the mold with a resin compound. Ensure that the actual conductor connections are made using one time use compression connectors and that each wire or cable enters the mold through its own port.

Furnish materials according to the Department's QPL.

725.16 Ground Rods. Ensure that each ground rod is one piece, at least 3/4 inch (19 mm) in diameter and 10 feet (3 m) in length with a driving point on the lower end. If of other than circular cross section, assure that the periphery of the rod is 4.7 inches (118 mm) or more. Ensure that the rod is of solid construction and is 100% stainless steel and UL listed.

Ensure that the rod bears a label denoting that it is UL listed.

Furnish materials according to the Department's QPL.

725.19 Power Service Components. Furnish the materials and equipment comprising a service pole, including service equipment, that meets the following requirements.

A. Service Entrance Conduit. Ensure that the service entrance or riser conduit is rigid galvanized steel with a rain tight galvanized steel service entrance head

(weatherhead) threaded to fit the conduit containing a composition insert for three conductors.

B. Service Disconnect. Ensure that the service disconnect is a properly rated fused switch of the ampacity specified and solid neutral. Ensure that the service fuses are cartridge fuses on the load side of the switch. Solid metal tie bars, when used to tie two or more circuit poles together on a fused disconnect and/or circuit breaker, shall be constrcted of 1/8-inch (min.) electrical-grade copper, not aluminum.

C. Lighting Contactor. Ensure that the lighting contactor is of the open type electromagnetically held.

Ensure that control of the contactor is through a photocell connected through a "HAND-OFF-AUTOMATIC" selector switch accessible only with the contactor enclosure open. Ensure that the control circuit is a separate circuit with its own protection.

D. Lighting Circuit Protection. Ensure that separate protection is provided on the load side of the lighting contactor for each lighting circuit and that such protection will open all line or phase conductors of the respective circuit should a fault occur on any one line or phase conductors.

E. Photoelectric Cell. Ensure that the photoelectric control is a twist-lock plug-in, utility grade, solid state, cadmium sulfide type of the proper voltage, rated for 1000 watts maximum load, with integral surge protection, a fail-safe mode in which the lighting circuits will remain energized, and a hermetically sealed case. Ensure that the nominal "turn on" level is 1 footcandle (10 lux) vertical and that the nominal "turn-off" level is 6 footcandles (65 lux) vertical with tolerances of 20 percent for the specified values. Ensure that the photocell has a time delayed response that will not respond to flashes of light from lightning, headlights of passing vehicles or emergency vehicle strobes and beacons. Ensure that the photoelectric control mounting bracket has a EEI-NEMA locking-type receptacle.

F. Switchgear Enclosure. Ensure that components are mounted on a removable back panel of 14 gage or heavier stainless steel rather than directly on the back wall of the enclosure and that the back panel mountings do not penetrate the walls of the enclosure. Provide a welded grounding stud on the enclosure interior.

Ensure that a neutral terminal bar of adequate ampere rating and with holes in number and of size to terminate each conductor separately is provided in each enclosure where neutral conductors are to be terminated. Ensure that an equipment grounding conductor terminal bar of adequate ampere rating and with holes in number and of size to terminate each conductor separately is provided in each enclosure where grounding conductors are to be terminated. When there is no code or utility company prohibition, a combination neutral and equipment grounding conductor bar may be furnished. Attach the grounding electrode conductor to the grounding stud. Provide a bonding jumper from the equipment grounding bar to the grounding stud.

Ensure that an enclosure containing a disconnect switch with an external operating handle allows that handle to be padlocked in either the "OFF" or the "ON" position.

Ensure that the enclosure containing the service disconnect switch has an interlock to prevent the door from being opened when the switch is in the "ON" position.

Ensure that the enclosure provides for padlocking the door.

Ensure that each switchgear enclosure is a NEMA ICS-1-110.15 Type 4 fabricated from No. 16 gage or heavier AISI Type 302 or 303 annealed stainless steel with fully welded seams and a brushed finish.

All fasteners used in assembly of the enclosures shall conform to ASTM A 320/A 320M (AISI-300 series).

G. Wiring Schematic, Wiring Diagram, Placards. Furnish both a schematic diagram and a wiring diagram of the entire power service from the power company service transformer secondary connection through the lighting branch circuit connections in triplicate with two copies delivered to the project and the third copy placed in the service disconnect enclosure. The Engineer will ensure that one of the two copies delivered to the project is filed with the project records and the other is delivered to the maintaining agency.

Ensure that each placard to be attached to an apparatus enclosure is of multiple layers of plastic thermally bonded together to provide a plate of at least 1/8 inch (3 mm) in thickness with engraved plain block letters at least 1/2 inch (12 mm) in height. Ensure that placards designating the function of the apparatus contained in an enclosure or other such information are of white letters on a black placard. Ensure that placards warning of high voltage possibly present in an enclosure or other such warning are of white letters on a red placard.

H. Customer Service Pole. Furnish a wood pole that complies with Supplement 1072. Ensure that the pole and any cross arms or pole key is Southern Pine or Western Red Cedar, full length, pressure treated in compliance with specifications of the American Wood Protection Association or AASHTO M-133. Ensure that the pole is 35 feet (10.5 m) minimum in length and Class 4 or heavier and conforming to ANSI 05.1 Specifications and Dimensions for wood poles. Ensure that the pole is reasonably straight without pronounced sweep or short crooks.

Ensure that all pole hardware, including racks, braces, straps, guy anchors, guy wire, clamps, bolts, nuts, washers, screws, nails, etc. is hot dip galvanized in accordance with 711.02.

Ensure that the grounding conductor is fastened to the pole with copper clad, rolled point staples of adequate size.

Ensure that the grounding conductor molding is either wood or plastic, in sections not less than 8 feet (2.4 m) long, of sufficient width and groove depth to completely enclose the grounding conductor.

Ensure that each pole anchor is of malleable iron or galvanized steel, 6 inch (150 mm) minimum diameter, two-way or four-way expanding type. Ensure that each anchor rod is 5/8 inch (16 mm) minimum diameter, 8 feet (2.4 m) minimum length galvanized steel with thimble eye. Ensure that each guy wire is 3/8 inch (10 mm) minimum diameter, conforming to ASTM A 475, galvanized steel.

I. Circuit Breakers. Ensure that circuit breaker assemblies for lighting control circuits are 100% rated for continuous (over 3 hours) operation by the manufacturer and labeled so, with a pre-defined minimum enclosure size, and housed in an enclosure sufficient to achieve the 100% rating.

725.21 Luminaire Supports. Ensure that the complete luminaire support from the luminaire(s) down through the connection to the foundation or other structure to which the luminaire support is attached conforms to the requirements of AASHTO's Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals LTS-6 (2013), except that the 40% hand-hole width criterion of 11.9.2 is not required. Ensure that the combined stress ratio above the first field joint is greater than the combined stress ratio at the base of the pole.

The design wind speed for all areas of the State shall be 90 mph (145 km/h).

The Department may require various tests including destructive tests at either the factory or on site prior to acceptance of a support in which case the Department's representative will supervise the Contractor and/or manufacturer as the appropriate entity performs the tests on supports selected at random by the Department from the lot produced for the project. Ensure that any support damaged by the testing is replaced at no additional cost to the Department.

Ensure that the support identification labels are adhesive labels with silver white reflective characters on a reflective green background meeting the requirements of 730.18.

Furnish certified luminaire supports according to Supplement 1091.

A. Light Poles. Ensure that the deflection of the pole from vertical when placed under the load of the bracket arm, and a weight of 55 pounds (25 kg) in place of each luminaire does not exceed an angle of 1 degree 40 minutes when tested in accordance with Supplement 1025 and that certified copies of the results obtained from the deflection tests are furnished the Laboratory.

A pole and arm constructed from either aluminum or steel but not a combination of the two may be furnished.

Ensure that each bracket arm is made from straight or tapered stock round or ovaliptic in cross section not less in size than 2 inch (50 mm) nominal pipe.

Ensure that the luminaire end of each bracket arm has an outside diameter equal to 2 inch (50 mm) pipe, is straight for a distance of eight inches (203 mm), with the longitudinal axis canted not less than 1 degree and not more than 4 degrees above horizontal.

Ensure that the bracket has an internal raceway with a minimum internal diameter of 1 3/32 inches (28 mm) free of projections and obstructions, which, when assembled to the shaft, will permit installation of luminaire supply conductors without insulation damage and which will not require bending the conductors to a radius less than 3 inches (75 mm).

Ensure that the pole does not have more than two sections, that the shorter section of a sectional is at the top and that the shorter section of a sectional pole is not less than 10 feet (3 m) in length. Ensure that the pole sections are joined by

telescoping the bottom of the upper section over the top of the lower section for a minimum length of 1 1/2 times the external diameter of the bottom of the upper section, driving the joint tight, and securing by through bolting with a stainless steel hex head bolt of a minimum diameter of 5/8 inch (16 mm).

Ensure that a pole section does not have more than one longitudinal, automatically electrically welded seam and no transverse seams. Ensure that the longitudinal welded seam is neat and uniform in appearance, that the weld is not less than the thickness of the base material and that the bead height does not exceed 1/16 inch (2 mm). Ensure that the wall thickness is uniform throughout, except at the weld bead. Ensure that the cross section of the pole is circular, or multi-sided with no less than eight sides and that the difference between the major and minor diameters of poles of circular cross section or the difference between the maximum and minimum distances across corners for poles of multi-sided cross section, measured at any point along the longitudinal axis, does not exceed 3/16 inch (5 mm).

Ensure that steel poles are tapered tubes with a true continuous taper not less than 0.06 inches per foot (1.5 mm per 300 mm) and not more than 0.16 inches per foot (4.0 mm per 300 mm).

Ensure that aluminum poles, either spun or cold rolled, are a true continuous taper except for the top and bottom sections which may be straight, that no more than 40 percent of the total shaft length is straight, and that the average rate of shaft taper including straight portions of the shaft is not less than 0.06 inches per foot (1.5 mm per 300 mm) and not more than 0.16 inches per foot (4.0 mm per 300 mm).

Ensure that the full design strength of the pole shaft section in bending can be transmitted through the base plate into the transformer base or the anchor bolts without permanent bending of the base plate or failure of the pole shaft to base plate connection.

Ensure that there is a “J” hook inside the pole just below the top on which to hang the pole and bracket cable support assembly.

Ensure that nonstructural castings for aluminum poles, including the pole cap are of ASTM B 26/B 26M or B 108, Alloy S 5 A, Condition F.

Ensure that steel poles and bracket arms are hot dipped galvanized after fabrication in accordance with the requirements of 711.02.

Furnish aluminum poles and bracket arms in natural aluminum with a satin brushed surface.

Ensure that each light pole is identified by a raised or engraved marking applied to the edge of the base plate which identifies the manufacturer and the year that the pole was manufactured and that such marking remains legible after the pole has been galvanized.

Ensure that bolts, nuts, washers and other fasteners used to assemble the light pole are of galvanized steel conforming to 711.02, stainless steel conforming to ASTM A 320/A 320M (AISI-300 series) or silicon bronze conforming to ASTM B 98M (B 98).

Ensure that each non-frangible steel transformer base is capable of transmitting the design dead, live, ice and wind loads of the light pole to be mounted on it to the foundation without failure or permanent deformation, has a flush door permanently attached by means of a top-mounted continuous stainless steel hinge, and is made from steel conforming to ASTM A36/A 36M hot dip galvanized after fabrication.

Ensure that each frangible aluminum transformer base is capable of transmitting the design dead, live, ice and wind loads of the light pole to be mounted on it to the foundation without failure or permanent deformation, has a flush aluminum door, bolted, or (if specified) permanently attached by means of a top-mounted continuous stainless steel hinge, and bears easily found and read durable labeling as to which AASHTO frangibility criteria the base meets. Ensure that the base has been tested and accepted by the FHWA as complying with the 1985 AASHTO frangibility requirements

Ensure that the bolts and nuts used to fasten the base plate of the pole to the transformer base are heavy hex conforming to ASTM A 307 and galvanized in accordance with 711.02. When either the top or the bottom of an aluminum transformer bases is to be fastened against non-galvanized steel, ensure that both the steel and the aluminum mating surfaces have been coated with a heavy film of zinc rich paint.

Ensure that the anchor bolts are ASTM F1554 steel with 55,000 psi (380 Mpa) minimum yield strength, are galvanized in accordance with 711.02 and that the nuts are capable of developing the full strength of the anchor bolt and are galvanized in accordance with 711.02.

B. Light Towers. Ensure that the structural design of the light tower is based on a load of six luminaires or the actual number of luminaires to be installed whichever is greater. Ensure that the structural design of the light tower is based on each luminaire weighing 75 pounds (34 kg) and having an effective projected area of 3.5 square feet (0.3 m^2) or the actual weight and effective projected area of each luminaire whichever is greater. Ensure that the structural design of the light tower is based on the head frame assembly with lowering device weighing 340 pounds (154 kg) and having a projected area of 5.3 square feet (0.5 m^2) or the actual weight and effective projected area of the head frame and lowering device whichever is greater.

Ensure that the luminaire lowering device (consisting of the luminaire ring, the head frame, the winch, the power cables and all miscellaneous mechanical and electrical equipment mounted in or on the pole) and the pole are compatible with each other.

1. Luminaire Ring. Ensure that the luminaire ring assembly is fabricated from steel which conforms to ASTM A 36/A 36M and that the ring is fitted with a separate 2 inch (50 mm) nominal steel pipe mounting arm directly attached to the ring for each luminaire.

Ensure that the luminaire ring is supported by three wire ropes equally spaced around the ring. Ensure that the three wire ropes are of the same material and construction. Ensure that the wire rope for this purpose is 3/16 inch (5 mm)

minimum diameter aircraft grade stainless steel control cable composed of 7 strands of 19 wires each. Ensure that each wire rope support cable is connected to the ring by a corrosion resistant device that will allow the connection to develop the full breaking strength of the wire rope while permitting ready adjustment of the length of the wire rope to level the ring. Ensure that the ring is equipped with a minimum of three spring loaded roller tipped centering arms equally spaced around the ring that are in continuous contact with the pole shaft and that the guide arm rollers are of a nonabrasive, water resistant material.

Ensure that the luminaire ring is equipped with three positive latching devices equally spaced around the ring that latch to the head frame supporting the ring in the raised position allowing tension to be removed from the lifting cables. Ensure that all moving parts of each latching device are part of the ring portion of the latch assembly and that each latch assembly incorporates a reflectorized flag that is clearly discernible from the ground when the ring is latched to the head frame. Ensure that the latching sequence shall not exert a horizontal force sufficient to cause an excess of 4 g's acceleration upon the luminaires.

Ensure that the luminaire ring is equipped with a NEMA 4 corrosion resistant junction box for the connections between the main power cord bringing power to the ring and the separate power cords for each luminaire. Ensure that each power cord has copper conductors of adequate size and insulation, that each power cord is of suitable construction, and that each power cord enters the junction box through a weather tight cord connector. Ensure that there is a cord support capable of withstanding a load of 1 1/2 times the weight of the main power cord without damage to the cord transmitting the weight of the main power cord directly to the ring. Ensure that there is a weather tight power inlet on the luminaire ring which allows the main power cord in the base of the tower to connect to the ring when the ring is in the lowered position. Ensure that the junction box is equipped with a 600 volt class terminal block for the connections between the main power cord, the luminaire power cords and the power inlet cord. Ensure that each luminaire ring is identified by a raised or engraved marking applied in a prominent location which identifies the manufacturer and the year that the ring was manufactured and that such marking remains legible after the ring has been galvanized

2. Head Frame Assembly. Ensure that the head frame is fabricated from steel which conforms to the requirements of ASTM A 36/A 36M. Ensure that the head frame assembly is equipped with pulleys for the wire ropes hoisting cables and rollers for the main power cord to the luminaire ring. Ensure that each hoisting cable sheave has a tread diameter of 25 times the cable diameter for stainless steel, that the groove for the hoisting cable has a semi-circular in cross section with a radius of one-half the cable diameter plus 1/64 inch (0.4 mm), that the sheave has an oil-impregnated bronze bushing and that the shaft on which the sheave turns is of stainless steel. Ensure that the rollers for power cord run on AISI 304 stainless steel shafts between cold-rolled steel plates. Ensure that bending radius of the power cord is not less than 7 inches (180 mm). Ensure that keeper bars have been provided over the power cord and ring support cables to keep them in their respective tracks. Ensure that a guide is provided to separate the individual cables as they pass between the head frame and the top of the pole. Ensure that the head frame mechanism is protected from the weather by a domed cover of either copper free spun aluminum

or fiberglass. Ensure that each head frame is identified by a raised or engraved marking applied in a prominent location which identifies the manufacturer and the year that the head frame was manufactured and that such marking remains legible after the head frame has been galvanized.

3. Transition Plate. Ensure that there is a transition plate between the ring support cables and the main hoisting cable. Ensure that the luminaire ring support cables are secured to the transition plate by shop applied, swage-type fittings designed to develop a connection strength equal to the breaking strength of the cable and prevent abrasion of the cable by the transition plate. Ensure that there is a cord support capable of withstanding a load of the weight of the main power cord plus a wind load on the cord equal that of a 30 mph (48 km/h) wind perpendicular to the full length of the cord without damage to the cord connecting the main power cord to the transition plate.

4. Hoisting Winch. Ensure that the winch is of cast iron and steel construction with an integral enclosed lubricant bathed worm and gear drive having a reduction great enough to be self-locking. Ensure that the winch has a pulling capacity at least five times greater than that required to lift the load. Ensure that the winch drum diameter is not less than 4 inches (100 mm), that the drum flange diameter is at least 3 inches (75 mm) greater than the diameter of the drum. Ensure that there is a cable guide or follower to prevent cable buildup at the ends of the winch drum. Ensure that the support plate for the winch bears a durable tag which identifies the manufacturer, manufacturer's model and year of manufacture for the lowering device.

5. Winch Drive Unit (Portable Power Unit). Ensure that the winch drive unit is powered by a heavy duty reversing drill motor, minimum 560 W (3/4 horsepower) rating, 120 volt. Ensure that there is a mechanical slip clutch torque limiter incorporated into the output shaft and that there is a placard on the portable winch drive unit giving the settings and instructions for care of the torque limiter. Ensure that there is a separately packaged dry type isolated winding transformer included to permit operation of the drill motor from the lighting circuit by plugging into the luminaire power cord outlet in the base of the tower. Ensure that the cord outlet and plug for connecting the motor to the transformer are NEMA L5-15 devices. Ensure that he hoisting rate is between 15 and 25 feet per minute (4 and 8 m/min). Ensure that the hand control switch incorporates 20 feet (6 m) of cable to allow operation of the lowering device from a position away from the pole and not beneath the ring and luminaires. Ensure that each winch drive unit frame is identified by a raised or engraved marking applied in a prominent location which identifies the manufacturer and the year that the portable power winch drive unit was manufactured and that such marking remains legible after final finish has been applied to the frame.

6. Connection of Tower to Lighting Circuit. Ensure that there is a separate terminal block for each conductor of the supply circuit in the base of the tower, and that there are enough spaces on the blocks to allow the incoming circuit to split into three outgoing directions in addition to the feed to the tower itself. Ensure that the terminal block has set screw style terminations, sized for 4 AWG - 1/0 AWG for the incoming and outgoing lighting circuit and 12 AWG - 10 AWG

for the tower wiring. Ensure that there is a circuit breaker in a NEMA 3R,4, or 4X enclosure located electrically after the terminal blocks for the lighting circuit and before the power cord leading up the tower to the luminaires. Ensure that the breaker enclosure is internally mounted and that the breaker is readily accessible through the tower hand hole. Ensure that the circuit breaker is a bolt on design, sized at 15 amperes with a minimum interrupting capacity of 14,000 amperes for 480 volt circuits or sized at 20 amperes with a minimum interrupting capacity of 10,000 amperes for 240 volt circuits and is of a single handle rather than a tied handle design with one pole for each line or phase conductor. Ensure that cord connector, plug and inlet on the ring for electrical power to the luminaires are NEMA L8-20 devices for 480 volt systems or are NEMA L6-30 devices for 240 volt systems.

7. Operating Manual. Furnish a complete manual including instructions on installation, operation and maintenance for each type of the following: lowering device, winch assembly and portable power winch drive unit.

8. Shaft. Ensure that shaft of the tower is of not more than four round or multi-sided tapered steel sections for towers up to and including 100 feet (30 m), five sections for towers over 100 feet (30 m) up to and including 120 feet (37 m), and six sections for towers over 120 feet (37 m). Ensure that the shaft is of steel having a minimum yield strength of 55,000 psi (379 MPa). Ensure that the shaft sections are joined by telescoping the bottom of the upper section over the top of the lower section for a minimum length of 1 1/2 times the external diameter of the bottom of the upper section or two feet (0.6 m) whichever is greater and driving the joint tight. Ensure that the sections have been pre-fitted and match-marked at the factory. Ensure that the inside surface of the shaft is relatively smooth and that there are no more than two longitudinal welds which shall be made by automatic electric arc welding. Ensure that the longitudinal seam welds have complete penetration, are of uniform density, are no thinner than the shaft material and not more than 20 percent thicker than the shaft material. Ensure that the base plate is fabricated from steel which conforms to the requirements of ASTM A 36/A 36M and that the shaft is joined to the base plate using the American Welding Society prequalified joint TC-U4a-S or TC-U4c-GF. Ensure that the hand hole in the shaft is properly reinforced to avoid stress risers and that the reinforcements are welded to the shaft using a joint and techniques designed to insure total penetration plus an outside fillet equal to the thickness of the shaft material. Ensure that all welds in the shaft satisfy AWS D 1.1 Structural Welding Code Article 9.25.3 for tensile stress when tested either by the ultrasonic method or by an approved alternate method, and that certified results are furnished to the Laboratory. Ensure that the door is fabricated from the same type steel as the shaft, is attached with a continuous stainless steel hinge having non-removable stainless steel hinge pins, fits the opening closely, and is securely held shut. Ensure that there are provisions for padlocking the handhole door closed and that each tower has been furnished with a vandal resistant padlock having a bronze or brass lock body and a corrosion-protected steel shackle keyed to the key number specified by the maintaining agency. Ensure that there are two holes, tapped 1/2-13, 180 degrees apart provided at the base of the tower for the grounding conductors. Ensure that the shaft shall be hot dipped galvanized after fabrication in accordance with the requirements of 711.02. Ensure that each shaft is identified by a raised or engraved marking applied to the edge of the base plate which identifies

the manufacturer and the year that the shaft was manufactured and that such marking remains legible after the pole has been galvanized.

9. Anchor Bolts and Nuts. Ensure that each anchor bolt is steel conforming to ASTM F1554, Grade 55, and galvanized in accordance with 711.02. Ensure that the nuts used with each anchor bolt are capable of developing the full strength of the anchor bolt.

725.22 Underground Warning / Marking Tape. Furnish tape that is an inert material, at least 5 inches (125 mm) wide composed of polyethylene or polypropylene plastic, highly resistant to alkalis, acids or other chemical components likely to be encountered in soils. Furnish tape in accordance with the ORC 3781.29 color code and with black identifying lettering in accordance with Table 725.22-1 printed on one side only.

TABLE 725.22-1 UNDERGROUND UTILITY FACILITY COLOR CODES

Identifying Lettering	Color
ELECTRIC	Red
GAS	Yellow
COMMUNICATION	Orange
WATER	Blue
SEWER	Green

Furnish tape in continuous rolls with the identifying lettering repeated continuously the full length of the tape. Unless otherwise noted, furnish tape containing a high-strength core with a break strength of at least 3000 lb (1361 kg) when tested to ASTM D6775. Provide certified data verifying compliance with these requirements

726 BARRIER REFLECTOR MATERIALS

726.01 Barrier Reflectors. Furnish concrete barrier, cable barrier, retaining wall, bridge parapet, bridge rail or guardrail blockout reflector body housings of the following Type:

Type 1, Barrier Reflector. Furnish concrete barrier, retaining wall, bridge parapet, or bridge rail reflector body housings that are made of acrylic or polycarbonate plastic . Ensure that the minimum reflective surface area of the reflector is 7 square inches (4400 mm²).

Furnish white reflectors that reflect the following minimum candela of light at the indicated observation angles for each 1 foot-candle (10.76 lx) of incident light at the indicated entrance angles. Furnish amber reflectors that reflect at least 60 percent of these values.

MINIMUM SPECIFIC INTENSITY, CD/10.76 LX

	Observation Angle	
Entrance angle	**0.2°**	**2.0°**
-4°	62	0.25
15°	52	0.18

The entrance angle is measured in the horizontal plane between the direction of incident light and normal to the face of the reflector. The observation angle is measured in the vertical plane between the observer's line of sight and the direction of light incident to the reflector face.

Type 2, Barrier Reflector. Furnish corrosion resistant metal guardrail blockout reflectors that are a minimum size of 4.5 × 10 × 0.125 inches (112.5 × 250 × 3.1 mm) with 1/4" (6 mm) predrilled mounting holes. One or both sides shall be covered with a minimum 4.5 × 5 inches (112.5 × 125 mm) of Type G, H or J reflective sheeting.

Type 3, Barrier Reflector. Furnish acrylic or polycarbonate plastic guardrail blockout reflector housings with 1/4" (6 mm) predrilled mounting holes. Products shall be structurally reinforced to withstand the force of thrown plowed snow. New products will be tested by the Department for a minimum of one winter season before approval. One or both sides shall be covered with a minimum 4.5 × 5 inches (112.5 × 125 mm) of Type G, H or J reflective sheeting.

Type 4, Barrier Reflector. Furnish spring loaded guardrail blockout reflector (reflector plate, holding arm and holding plate) made of plastic with UV protection.

The reflector plate shall have a minimum size of 5.33 x 6.33 x 0.150 inches. One or both sides of the reflector plate shall be covered with a minimum 5.0 x 6.0 inches of Type G, H or J reflective sheeting.

The total height of the Spring Loaded Guardrail Blockout Reflector shall be 26.00 inches, which includes the reflector plate, holding arm and holding plate.

The holding plate shall have 2 predrilled holes for 5/11x 1 1/14 inch long leg screw.

The spring shall be made of 0.135 phos-music wire conform to ASTM-A228-07 standard specification requirements.

Type 5, Barrier Reflector. Furnish L-type guardrail blockout reflector 6.50"x11.38" (reflective and mounting plate) made of durable, flexible high density polyethylene (HDPE) plastic with UV protection.

The reflective plate shall have a minimum size of 6.50"x4.25" inches. One or both side of the reflective plate shall be covered with a minimum of 26.0 square inches Type G, H or J reflective sheeting.

The mounting plate shall have two (2) 1/2" (12.7 mm) predrilled mounting holes.

Furnish materials according to the Department's QPL.

Type 6, Cable Barrier Reflector. Furnish nylon, or polycarbonate plastic cable barrier reflectors. Products will have a minimum of 22.5 square inches of Type G,

H, J, or Reboundable reflective sheeting visible to drivers traveling in both directions. Products will either be attached to the cable or ground mounted. Ground mounted products will meet the requirements of 720.03. Use products that are structurally reinforced to withstand the force of thrown plowed snow. New products will be tested by the Department for a minimum of one winter season before approval.

730 TRAFFIC SIGN AND SUPPORT MATERIAL

730.01 Steel Tube and Pipe. Furnish steel tube and pipe according to ASTM A 53, Grade B, ASTM A 500, Grade B, or ASTM A 501, except provide tubing for truss and end frame diagonals according to 711.01.

730.015 U-Channel Posts. Furnish U-channel posts fabricated from steel into a characteristic cross-section that may be used alone or paired to form a heavier post by being bolted together back to back. Furnish posts with a uniform cross section for their full length. Cut posts square to a length tolerance ±1 inch (±25 mm) and ensure that posts do not have ragged or sharp edges, or cracks or other imperfections affecting strength or durability. The back of the posts may be flat or contain raised longitudinal ribs.

Furnish posts meeting the deflection criteria of Supplement 1075. Furnish posts manufactured from rail or billet steel according to ASTM A 499, Grade 60.

Furnish posts with a nominal weight before punching or galvanizing as follows:

Post Size Number	Weight lb/ft (kg/m)	Tolerances %
1	1.12 (1.7)	-3.5, +10.0
2	2.00 (3)	-3.5, +10.0
3	3.00 (4.5)	-3.5, +10.0

Furnish posts with 3/8-inch (10 mm) diameter holes accurately punched on the centerline spaced at 1-inch (25 mm) centers beginning not more than 1 1/8 inches (30 mm) from the top of the post through the entire length, to allow bolting the posts back to back, without redrilling, using 5/16-inch (8 mm) diameter bolts. Furnish posts that have been galvanized after punching according to 711.02.

Furnish materials according to the Department's QPL.

730.016 Square Posts. Furnish square posts fabricated from steel according to ASTM A 1011 with a minimum yield strength of 60,000 pounds per square inch (415 MPa), with 7/16-inch (11 mm) diameter die-cut knockouts or open holes spaced on 1-inch (25 mm) on the centerline of all four sides, in true alignment and opposite each other. Furnish posts with the dimensional requirements conforming to the Department's standard drawings. Furnish posts that have been finished with one of the following methods:

A. Both inside and outside of the post are hot-dip galvanized according to ASTM A 653 G-235.

B. The outside of the post has a zinc coating of 0.80 ounce per square foot (244 g/m^2) followed by chromate conversion coating and a cross-linked polyurethane acrylic coating. The inside of the post has a zinc organic coating.

Furnish materials according to the Department's QPL.

730.017 Wooden Box Beams. Furnish wooden box beams fabricated from 1/10 or 1/8 inch (2.54 or 3.18 mm) thick laminated veneers with the grain oriented parallel to the length of the finished beam and the veneers glued together in a continuous process with lap or scarf joints connecting successive veneers in each layer staggered throughout the thickness of the beam. A 45 degree miter shall be used for the corner joints. The adhesive used shall be a phenol-formaldehyde which conforms to ASTM D 2559. The beams shall be pressure treated with a preservative meeting AWPA Standard U1, Commodity Specification F: Composite Materials.

730.02 Steel Anchor Bolts and Nuts. Furnish anchor bolts made of steel conforming to ASTM F1554 Grade 105, galvanized according to 711.02 at least 2 inches (50 mm) beyond the threads, with the end either bent or with a drilled and tapped steel plate. Furnish leveling nuts and anchor nuts capable of developing the full strength of the anchor bolt.

Furnish materials according to the Department's QPL.

730.03 Steel Poles and Arms. Furnish poles and arms made of steel with a minimum yield strength of 52,000 pounds per square inch (359 MPa) and galvanized according to 711.02.

Furnish certified material according to Supplement 1093.

730.04 Base and Arm Plates. Furnish support or pole anchor bases and arm attachment plates fabricated from steel plate according to ASTM A 36 (A 36M) or ASTM A 572 (A 572M), Grade 42. Weld plates to supports, poles, or arms both inside and outside with fillet or full penetration welds equal to the wall thickness, or by AWS prequalified welding joints TC U4a-S or TC U4c-GF. The Contractor may use a cast steel base of equivalent strength.

Furnish certified material according to Supplement 1093.

730.05 Handhole Covers. Furnish handhole covers for poles and overhead sign supports made of 0.109-inch (2.7 mm) galvanized steel or 0.125-inch (3 mm) nominal aluminum alloy.

Furnish certified material according to Supplement 1093.

730.06 Pole Caps. Furnish pole caps made of aluminum, galvanized ferrous metal, or zinc die casting.

Furnish certified material according to Supplement 1093.

730.07 Arm Caps. Furnish arm caps made of steel that cover at least 50 percent of the end area.

Furnish certified material according to Supplement 1093.

730.08 Steel Hardware. Furnish bolts 5/8-inch (16 mm) diameter or larger according to ASTM A 325 (A 325M). Furnish bolts and screws less than 5/8-inch (16 mm) diameter according to SAE J429, Grade 5. Furnish nuts of all size, except

anchor nuts and leveling nuts, according to SAE J995, Grade 2. Furnish flat washers according to ANSI B18.22.1. Furnish lock washers according to ASME B18.21.1. Furnish U-bolts according to ASTM A 307. Furnish all hardware that is hot-dipped galvanized according to ASTM A 153 or mechanically galvanized according to ASTM B 695, Class 50.

Furnish certified material according to Supplement 1092 or 1093.

730.09 Stainless Steel. Furnish any AISI 300 or 400 series stainless steel.

Furnish certified material according to Supplement 1093.

730.10 Stainless Steel Hardware. Furnish stainless steel hardware according to ASTM A 320/A 320M (AISI 300 series). Furnish bolts, screws, nuts, washers, handhole cover chains, and U-bolts that are passivated commercial grade.

Furnish certified material according to Supplement 1092 or 1093.

730.11 Aluminum Sheet and Plate. Furnish sheets for extrusheet panels according to ASTM B 209 (B 209M), 3003-H18, or 5052-H38. Furnish sheets for flat sheet and overlay signs, and sign post reflectors, according to ASTM B 209 (B 209M), 3004-H38, 5052-H38, or 6061-T6. Furnish plates for sign support structures according to ASTM B 209 (B 209M), 6061-T6.

Furnish certified material according to Supplement 1092 or 1093.

730.12 Aluminum Extrusions. Furnish extruded panels and extrusions for extrusheet panels according to ASTM B 221 (B 221M), 6063-T6. For sign support structures, provide rolled or cold finished bar, rod, and wire according to ASTM B 211 (B 211M), 6061-T6; provide extruded bars, rods, shapes, and tubes according to ASTM B 221 (B 221M), 6061-T6.

Furnish certified material according to Supplement 1092 or 1093.

730.13 Aluminum Tube and Pipe. Furnish seamless pipe and seamless extruded tube according to ASTM B 241/B 241M, 6061-T6. Furnish extruded structural pipe and tube according to ASTM B 429, 6061-T6.

Furnish certified material according to Supplement 1092 or 1093.

730.14 Aluminum Castings. Furnish certified material according to Supplement 1092 or 1093.

A. Furnish sand castings according to ASTM B 26/B 26M, 356-T6 or T7.

B. Furnish self-aligning aluminum extrusheet sign mounting clips with manufacturer identification mark conspicuously incorporated in relief on the top surface of the casting, and in accordance with Supplemental Specification 992.

C. Furnish permanent mold castings according to ASTM B 108, 356-T6 or T7.

730.15 Aluminum Forgings. Furnish forgings according to ASTM B 247 (B 247M), 6061-T6.

Furnish certified material according to Supplement 1092 or 1093.

730.16 Aluminum Welding Rods. Furnish welding rods according to AWS ER-4043.

730.17 Aluminum Hardware. Furnish hardware according to:

	ASTM Designation	Alloy	Condition/Temper
Bolts and screws	B 211 (B 211M)	2024 6061	T4 T6
Studs-welded	B 211 (B 211M)	1100	H16
Nuts-hex	B 211 (B 211M)	6061 6262	T6 T9
Nuts-lock	B 211 (B 211M)	2017	T4
Washers-flat	B 209 (B 209M)	Clad 2024 6061	T4 T6
Lock washers	B 211 (B 211M)	7075	T6
Rivets-solid	B 316/B 316M	6053 6061	T6 T6
Rivets-blind	B 316/B 316M	2017 2117 5052	F F F

In addition, provide break-mandrel aluminum blind rivets with a stainless steel or aluminum mandrel.

Furnish certified material according to Supplement 1092.

730.18 Reflective Sheeting Type F. Furnish sheeting according to ASTM D 4956, Type I, including supplemental requirement S1.

730.19 Reflective Sheeting Type G. Furnish Type G reflective sheeting of microprismatic construction according to Supplement 1049, and according to ASTM D 4956, Type IV, including supplemental requirement S1. Do not furnish material of glass bead construction.

Furnish materials according to the Department's QPL.

730.191 Reflective Sheeting Reboundable. Furnish reboundable reflective sheeting according to Supplement 1049, and according to ASTM D 4956, Type III, IV, VIII, IX or XI, including supplemental requirements S1 and S2, with watermarks or other identification marks inconspicuously incorporated into the face of the sheeting on a repeating pattern if necessary to distinguish the sheeting from other similarly appearing sheetings.

Furnish materials according to the Department's QPL.

730.192 Reflective Sheeting Type H. Furnish Type H reflective sheeting according to Supplement 1049, and according to ASTM D 4956, Type VIII including supplemental requirement S1.

Furnish materials according to the Department's QPL.

730.193 Reflective Sheeting Type J. Furnish Type J reflective sheeting according to Supplement 1049, and according to ASTM D 4956, Type IX or XI, including supplemental requirements S1.

Furnish materials according to the Department's QPL.

730.20 Nonreflective Acrylic Opaque Sheeting. Furnish non-reflective acrylic opaque sheeting according to ASTM D 4956, except provide sheeting that does not incorporate any optical elements.

730.22 Silk Screen Inks. Furnish opaque and transparent process color inks used in the silk screen process that the manufacturer of the reflective sheeting accepts and warrants according to Supplement 1049. Use inks that provide a tough, durable film of uniform thickness and appearance on the sign surface. Furnish transparent process color inks used in the reverse screen process according to the Daytime Color Specification Limits table in ASTM D 4956.

730.23 Transparent Acrylic Electronic Cuttable Films. Furnish transparent acrylic electronic cuttable films the manufacturer of the reflective sheeting warrants according to Supplement 1049. Use films that provide a uniform appearance on the sign surface. Furnish films according to the Daytime Color Specification Limits table in ASTM D 4956.

730.24 Digital Printing. Fabricate digitally printed signs using opaque and transparent color inks along with a clear UV overlaminate protectant film applied to the entire sign surface, sticker surface, or both that the manufacturer of the reflective sheeting guarantees according to Supplement 1049. Temporary work zone signs with black ink only do not require protective film. Ensure digitally printed colors meet the applicable daytime and nighttime color requirements of ASTM D4956 "Standard Specification for Retroreflective Sheeting for Traffic Control."

Sign fabricators using digital printing methods to produce regulated traffic signs must be certified by the manufacturer of the reflective sheeting whose materials are used to produce the delivered signs. Certified sign fabricators must undergo an audit process by the manufacturer of the reflective sheeting to ensure they have the proper training, equipment, color calibrations, manufacturing capabilities, manufacturing application processes and the materials required to fulfill the sheeting manufacturer's warranty obligations. Sign fabricators must recertify annually with the manufacturer of the reflective sheeting or utilize a 3rd party certifier approved by the manufacturer of the reflective sheeting. ODOT may require proof of Sign Fabricator Certification with the execution of a purchase order (P.O.) or construction contract for signs.

731 SIGN LIGHTING AND ELECTRICAL SIGNS MATERIAL

731.03 Changeable Message Sign, Electrical Type.

A. General. Electrical changeable message signs consist of units or groups of units containing arrangements of pixels that use electrical circuitry to display different messages.

Place signs in weatherproof cabinets. Integrate control logic units, load switches, monitor feedback circuits, power supply, etc., within the sign cabinet or mount within a separate weatherproof enclosure as required.

B. Message Type. Furnish electrical changeable message signs of the limited message or unlimited message type.

Limited message signs contain pixels in an arrangement so that by the energizing of selected pixels two or more messages may be displayed.

Unlimited message signs contain pixels arranged in full matrix or alphanumeric type modules positioned side-by-side to provide line units of the specified length. Ensure that the line units are capable of displaying messages containing letters and numerals, limited only by the number of characters that can be accommodated. Ensure that the line units are capable of continually displaying alternating messages.

Furnish materials according to the Department's QPL.

C. Display Type. Furnish electrical changeable message signs consisting of lamp, light emitting diode, fiber optic, light reflecting, or hybrid types.

Lamp type changeable message signs consist of individual incandescent bulbs.

Light emitting diode changeable message signs consist of groups of individual light emitting diodes that, acting together, form individual character pixels.

Fiber optic changeable message signs consist of fiber optic bundles that transmit light from a remote source to form individual pixels.

Light reflecting changeable message signs consist of individual light reflecting panels.

Hybrid changeable message signs consist of individual light reflecting panels, each augmented by a light emitting pixel of the specified type. Ensure that the light emitting pixels are displayed when the corresponding reflecting panel is in the exposed position, and concealed or de-energized when the corresponding reflecting panel is in the unexposed position.

Furnish materials according to the Department's QPL.

731.05 Internally Illuminated Fixed Message Sign. Furnish internally illuminated fixed message signs of the required legend and that consist of an opaque housing with a face of translucent plastic. If specified, provide double faced signs. Illuminate signs using interior lamps located so the sign face is uniformly lighted.

Furnish signs either with the legend on the exterior surface to maintain legibility when unlighted due to power failure, or with the legend on the interior surface so as to be invisible when the sign is unlighted. Apply the legend using black silk screening or by direct applied characters to white sign faces, unless otherwise specified. Design the sign faces for quick removal for maintenance, and provide faces with a safety chain or like device. If specified, shield the sign faces with sunscreens, louvering, or visors.

Furnish housings made of corrosion-resistant material that is cast, extruded, or formed. Furnish mounting hubs that are similar to traffic signal design. Furnish weatherproof signs that have drainage weepholes.

Furnish the sign with the appropriate hardware for mounting by span wire, mast arm, pedestal top, or pole type bracket arms. Include fluorescent type lamps with ballast or LED light source.

Furnish materials according to the Department's QPL.

731.06 Sign Flasher Assembly. Furnish beacons consisting of single traffic signal sections with 8 or 12-inch (200 or 300 mm) yellow lenses. Ensure that the flasher control unit flashes the beacons at a rate for each beacon of between 50 to 60 times per minute with the light period from one-half to two-thirds of the total cycle. Furnish flasher control units that have all solid state components and that meet NEMA TS-2. House control units within a weatherproof corrosion-resistant enclosure with a lockable door. Include the LED lamps.

Ensure that the manufacturer of LED beacons is listed on the Department's TAP List for LED signal lamps.

Furnish materials according to the Department's QPL.

731.07 School Speed Limit Sign Assembly. Furnish yellow beacons that are 8 inches (200 mm) or 12 inches (300 mm). Ensure that the flashers flash the beacons alternately at a rate for each beacon of 50 to 60 times per minute with the light period from one-half to two-thirds of the total cycle. Furnish flashers that have all solid state components and that meet NEMA TS-2. Ensure that the backing members with hardware are compatible with the method of support.

Ensure that the manufacturer of LED beacons is listed on the Department's TAP List for LED signal lamps.

Furnish materials according to the Department's QPL.

731.08 Flexible Conduit. Furnish galvanized steel flextube conduit with a waterproof PVC jacket according to UL 360 for wiring of lighted signs. Conduit must be labelled clearly as Sunlight Resistant, meeting the requirements of NEC Art. 300 and 350.

Furnish materials according to the Department's QPL.

731.10 Timer with Enclosure. Furnish a timer that allows automatic sign operation for a minimum of 8 times per day and for selected days of the week. Furnish a solid state timer with a back-up battery to maintain timekeeping and program memory for at least 48 hours. Furnish a battery with a design life of 10 years under field conditions when power failures over the 10-year period would accumulate to 100 days. If installed outdoors, house the timer within a lockable, weatherproof, corrosion-resistant enclosure. Furnish each enclosure with at least one padlock complying with 631.06.

Furnish materials according to the Department's TAP List.

732 TRAFFIC SIGNAL MATERIAL

732.01 Vehicular Signal Heads, Conventional. Ensure that vehicular traffic signal heads conform to the ITE "Vehicle Traffic Control Signal Heads" standard. In conformance with the above standard, provide signal heads that are of cast

nonferrous corrosion resistant metal. For span mounted and non-tethered and free swinging installations, and for span mounted with tether and backplates or rigid mounted, use polycarbonate plastic heads with coloring obtained through colored plastic and not painted.

Traffic signals consist of specified assemblies of optical sections containing 12-inch (300 mm) diameter lens opening, a housing, a door frame with stainless steel hinge pins and latching device, visor, wiring, and includes LED lamp in accordance with 732.04. Retention hardware for LED lamps, if sharing threaded hole with visor hardware, shall consist of minimum 1/2-inch (13 mm) long, set screw with retaining tab and captive wingnut or hex nut. All hardware shall be stainless steel and set screw shall be inserted into signal section door using visible, semi-permanent threadlocking compound. All hardware used to join optical sections together shall be stainless steel.

Furnish signal heads with required mounting hardware. Furnish signal face orientation to traffic by serrated rings or other devices on housing sections and mounting hardware. Permit adjustment in increments not greater than 5 degrees of rotation and not affected by wind gusts when locked. Furnish galvanized steel or aluminum spacers and drop pipes 1 1/2 inches (38 mm) nominal pipe size (1.90 inch (48 mm) actual diameter). Ensure that disconnect hangers have at least twelve terminals unless a greater number is required. Tethered heads shall use 3/4-inch unpainted cast aluminum span wire clamps and cable entrance adapters with integral tri-studs (no tri-stud inserts), stainless steel hardware, and a single steel-reinforced mounting hole. Free-swinging heads shall use cast iron span wire clamps and cable entrance adapters with tri-studs. Tri-studs shall be secured to the head using stainless steel nylon-insert or distorted thread locknuts. A neoprene gasket placed under the clamp washer in the top signal section shall effectively seal the entrance adapter on the signal to make a waterproof connection and shall have a minimum thickness of 3/32 inch. Provide cutaway visors, unless specified otherwise, with all heads, and the inside surface of the visors shall have a finish of flat black. All other exterior surfaces of the signal head and hardware shall have a finish of Federal Yellow or Gloss Black to closely agree with Federal Standard 595, Color 13655 or Color 17038. The coating system used shall be durable, uniform, and weather resistant.

For polycarbonate signal heads, ensure a minimum wall thickness of 0.11 in (2.79 mm).

Furnish materials according to the Department's QPL.

732.02 Vehicular Signal Heads, Optically Programmed, 12-inch (300 mm) Lens. Ensure that the signal sections conform to applicable portions of the ITE standard and 732.01. Furnish and mount optical sections with a 12-inch (300 mm) lens size alone or in combination with additional sections of optically programmed or conventional optics types to form signal faces and heads. Furnish an optically programmed signal section that includes an LED lamp.

Balance adjusters, used only if specified, shall have a splined eyebolt design and splined external clamping body. All assembly hardware shall be stainless steel.

Furnish a visor with each signal section.

Cable entrance adapters shall be of the tri-stud type with stainless steel hardware. A neoprene gasket placed under the clamp washer in the top signal section shall effectively seal the entrance adapter on the signal to make a weatherproof connection and shall have a minimum thickness of 3/32 inch (2.5 mm)..

Furnish materials according to the Department's QPL.

732.04 Signal Lamps.

A. Vehicular and Pedestrian Light Emitting Diode (LED) Lamps. Prequalify vehicular and pedestrian LED lamps according to Supplement 1097.

Furnish LED signal lamp units that meet or exceed all the requirements of the current Institute of Transportation Engineers (ITE) publications. LED module shall be certified by the Intertek LED Traffic Signal Module Certification Program, and each unit shall have a decal indicating Intertek certification.

All LED signal lamp units shall be the latest model currently in production and new. Equipment no longer being manufactured shall not be accepted, even if it meets the following specifications.

LED signal lamp units shall conform to the following criteria:

1. Physical and Mechanical Requirements

a. The LED traffic signal lamp unit shall be designed as a retrofit replacement for existing incandescent signal lamps and shall not require any special tools for installation. The 12" (300 mm) retrofit replacement LED traffic signal lamp unit shall fit into existing traffic signal housings built to ITE Vehicular Traffic Signal Heads (VTCSH) standards without modifications.

b. Installation of a retrofit replacement LED traffic signal lamp unit into an existing signal housing shall only require removal of the existing lens and incandescent lamp. The new unit shall fit securely in the housing door and connect to existing electrical wiring or terminal block by means of simple connectors. Removal of the reflector is optional.

c. Each LED signal lamp unit shall be identified on the back side with the following:

(1) Manufacturer's name and trademark
(2) Part number
(3) Serial number (must be unique for each unit)
(4) Voltage rating
(5) Power consumption (watts and volt-ampere)
(6) Vertical indexing indicator (i.e., "up arrow", or the word "UP" or "TOP") if specific orientation of the module is required.
(7) Date of manufacture (minimum information required - month & year)

Single units shall have identification markings as to the type and color of the module. Bi-Modals shall be marked with module type.

Each LED signal lamp unit shall have a label placed on the unit certifying compliance to ITE standards for color and luminance.

d. The LED traffic signal lamp unit shall be a single, self-contained device, not requiring on-site assembly for installation into an existing traffic signal housing.

e. The assembly and manufacturing process for the LED traffic signal lamp unit assembly shall be such as to assure all internal LED and electronic components are adequately supported to withstand mechanical shock and vibration from high winds and other sources. The LED signal lamp shall survive 3 drops of 42 inches onto a smooth concrete surface without any loosening or breaking of internal components, or change in operation.

f. The lens of the LED signal lamp unit shall be capable of withstanding ultraviolet light (direct sunlight) exposure for a minimum time period of five years without exhibiting evidence of deterioration.

g. Ensure that lenses will withstand a 42-inch (1.0 meter) drop test, are a minimum of 1/8 inch (3 mm) thick, and are free of bubbles and imperfections. The lenses shall be smooth on the outside with no external facets to prevent dirt and debris build up.

h. Each LED traffic signal lamp unit shall comprise a UV stabilized polymeric outer shell, multiple LED light sources, and a regulated power supply.

i. If red or yellow lenses are tinted, they shall match the wavelength (chromaticity) of the LED. Do not furnish green tinted lenses.

j. An optical assembly shall diffuse the light output and provide uniform illumination across the entire surface of the lens and eliminate the visibility of the individual LEDs to the observer. The optical assembly shall be used for all ball and arrow modules and shall be optional on pedestrian modules.

k. The LED traffic signal lamp unit shall be designed for universal installation in both span wire and standard/stationary pole mount applications.

l. The Arrow pattern produced by the Arrow LED traffic signal lamp units shall conform to the VTCSH standard for color, size and shape. The Arrow LED traffic signal lamp units shall not require a specific orientation or have a variance in light output, pattern or visibility for any mounting orientation.

m. LED pedestrian signal lamp units shall be designed as a retrofit replacement, modular or screw in unit for the message bearing surface of a 12" (300 mm) pedestrian traffic signal, type A-2, housing.

n. The LED pedestrian signal lamp unit shall fit into existing pedestrian signal housings without the need to modify the housing. Installation of the retrofit replacement LED pedestrian signal lamp unit into an existing 12" (300 mm) pedestrian signal housing shall only require the removal of the existing message bearing surface, existing lamp components (i.e. lens, lamp module, gaskets, and reflector) and insertion of the retrofit replacement into the area once occupied by the removed assembly.

o. The single pedestrian module shall be designed to display a full "HAND" icon and a full "Walking" Person icon that complies with standards for this (icon) symbol for the size specified.

p. LED traffic signal lamp units shall be visible at 450 feet (137 meters) during sway conditions (extended view) until obscured by the visor.

q. The module shall be designed to detect catastrophic loss of the LED load. Upon sensing the loss of the LED load, the module shall present a resistance of at least 250K Ohms across the input power leads within 300 msec.

2. Electrical Requirements

a. Each unit shall incorporate a regulated power supply engineered to electrically protect the LEDs and maintain a safe and reliable operation. The power supply shall provide capacitor filtered DC regulated current to the LEDs according to the LED manufacturer's specification.

b. The LED traffic signal lamp unit shall operate on a 60 Hz AC line voltage ranging as specified by ITE specifications. The circuitry shall prevent flickering over this voltage range. Nominal rated voltage for all measurements shall be 120 ± 3 volts RMS.

c. All unit types shall be operationally compatible with the traffic signal equipment that each type is designed and intended to interface with.

e. Two, captive, color coded, 600 V, 20 AWG minimum jacketed wires, 3 feet (0.9 m) long, conforming to the National Electric Code, rated for service at 221 °F (105 °C), are to be provided for an electrical connection.

f. The LED signal shall operate with a minimum 0.90 power factor.

g. Total harmonic distortion (current and/or voltage) induced into an AC power cabinet bus by any sample of 10 signal lamp units shall not exceed 20 percent. This value may be calculated using the root-mean-square combination of the measured harmonic distortion from one sample LED signal lamp unit.

h. LED signal lamp units and associated on-board circuitry shall conform to the requirements in Federal Communications Commission (FCC) Title 47, Sub Part B, Section 15 regulations concerning the emission of electronic noise.

i. The LED signal lamp units shall incorporate circuitry to ensure that they show no evidence of illumination for input voltages below 35 volts. LED signal lamp units shall be illuminated (unregulated illumination) for all input voltages higher than 45 volts AC but less than 80 volts AC. They shall have fully regulated illumination for applied voltages of 80 volts through 135 volts AC. Proof of the intended function of this circuitry shall be accomplished by connecting the lamps to a variable voltage source and slowly raising the applied voltage from zero volts up to 135 volts, and then slowly lowering the applied voltage from 135 volts to zero volts.

j. Proposed LED signal lamp units shall be less than or equal to the base wattage shown below at 77 °F (25 °C).

Retrofit	Wattage
12@ R 12" Red Ball	12 or less
12@ Y 12" Yellow Ball	22 or less
12@ G 12" Green Ball	15 or less
12@ Y 12" Yellow Arrow	10 or less
12@ G 12" Green Arrow	l9 or less

3. Environmental Requirements

a. Green and red LED traffic signal lamp units shall be rated for use in the ambient operating temperature range of -40 °F to +166 °F (-40 °C to +74 °C). Yellow signal lamps shall be rated at a range of -13 °F to +77 °F (-25 °C to +25 °C).

b. The unit shall consist of a housing that is a sealed watertight enclosure that eliminates dirt contamination and allows for safe handling in all weather conditions.

4. Documentation Requirements. Each LED traffic signal lamp unit shall be provided with the following documentation:

a. Installation instructions.

b. The manufacturer name, brand and model number of all LEDs used shall be provided, along with the LED manufacturer's recommended drive current and degradation curves.

5. Warranty. The LED signal lamp unit shall be repaired or replaced by the manufacturer if it exhibits a failure due to workmanship or material defects within the first 60 months of field operation.

The LED signal lamp unit shall be repaired or replaced by the manufacturer if, when operating over the specified operating ambient temperature and voltage ranges, the unit does not meet or exceed all minimum luminous intensity requirements as defined in the specifications during the first 60 months of field operation.

The measured chromaticity coordinates of LED signal lamp units shall conform to the requirements for chromaticity in the specifications over the temperature range provided in the Specifications for the duration of the warranty period.

The manufacturer shall provide a written warranty against defects in materials, workmanship and luminous intensity for LED signal lamp units for a period of 60 months after installation of LED signal lamp units. Replacement LED signal lamp units shall be provided within 10 days after receipt of failed LED signal lamp units at no cost, except the cost of shipping the failed units.

An LED pedestrian signal lamp unit shall be repaired or replaced by the manufacturer if the signal lamp unit does not attract the attention of, or is not readable to, a viewer (both day and night) at all distances from 10 feet (3 meters) to the full width of the area to be crossed when operated over the specified operating ambient temperature and voltage ranges.

Furnish materials according to the Department's TAP List.

732.05 Pedestrian Signal Heads. Furnish pedestrian signal heads that conform to the ITE specifications. Ensure that the signal heads alternately display the symbol of an upraised hand in Portland orange and the symbol of a walking person in white light. Do not furnish outline style symbols. Furnish material for housings that consist of cast or sheet, corrosion resistant, non-ferrous metal or polycarbonate plastic, as specified in the plans. Adequately reinforce the housings. Ensure that the lens frames are non-ferrous metal or polycarbonate material.

Ensure that the lenses are glass or ultraviolet and impact-resistant plastic and display the legend with translucent symbols within an opaque black background.

Seal the lens to the door frame by the use of a weatherproof seal. Furnish an elastomeric gasket between the door frame and housing to ensure a dust and weatherproof seal.

Use a signal head design that provides adequate dissipation of heat.

Furnish pedestrian signal heads with required mounting brackets. Furnish either pipe type brackets or, when compatible with the mounting position required by the plans, two-piece hinged type brackets that support the signal head close to the pole.

Furnish 1 1/2-inch (38 mm) galvanized steel pipe brackets with necessary fittings and adapters, and that are one-way or two-way as required. Orient the signal face to crosswalks by selective meshing of serration rings or other devices provided on housings and mounting brackets. Make adjustment in increments not greater than 5 degrees of rotation and that is not affected by wind gusts when locked.

Furnish two-piece hinged brackets of cast aluminum with stainless steel hinge pins, and when closed will be secured by a tamperproof bolt. Ensure that the mounting incorporates a terminal block for quick disconnect of field wiring. Ensure that the mounting design permits attachment to the pole by banding, bolting or by lag screws in the case of wood poles.

Finish signal exterior surfaces black with enamel coating. Finish interior surfaces of visors flat black.

For polycarbonate signals, proper exterior colors shall be obtained by use of colored plastic material rather than painting.

Also for polycarbonate signals; pipes, spacers and fittings constructed of polycarbonate plastic may be used in lieu of galvanized steel or aluminum.

Furnish pedestrian signal head types according to Table 732.05-1.

TABLE 732.05-1

Signal Head Type	Symbol Height, Inches, (mm)	Light Source
A1 A2	6 (152) 9 (229)	LED
D2	9 (229)	LED

If specified, furnish the types listed below:

A. Type A1. Furnish a signal head that utilizes the housings of two 8-inch (200 mm) lens type vehicular traffic sections connected together to form a vertical unit. Ensure that the sections have square lenses. Ensure that the upper lens displays the symbol of an upraised hand in portland orange and the lower lens will display the symbol of a walking person in white .

Furnish materials according to the Department's QPL.

B. Type A2. Furnish a signal head that utilizes the housings of two 12-inch (300 mm) lens type vehicular traffic sections connected together to form a vertical unit. Ensure that the sections have square lenses with the same symbol position as Type A1. Furnish materials according to the Department's QPL.

C. Type D2. Furnish a single housing signal head with a lens in one piece or in two sections, one for each message. Color and mask the lens to display in portland orange the symbol of an upraised hand from the left compartment and the symbol of a walking person in white from the right compartment. Install a lamp in each compartment. The upraised hand and the walking person symbols may be integral in the same compartment.

D. Countdown.

1. Operation.

a. Display driver shall be designed to allow individual LED failures without affecting other LEDs in the same display.

b. The countdown timer shall be of the "smart" type, which continuously samples the timing intervals presented by the pedestrian signal load switch driver(s) in order to "learn" the programmed timing being used by the controller.

c. During interval sampling time, the countdown timer numerical display shall be blank.

d. Sampling time to determine interval settings shall take a maximum of two complete signal cycles.

e. The unit shall be capable of displaying a countdown commencing at the onset of the pedestrian clearance interval and reaching zero at the end of the pedestrian clearance interval.

f. Any interruption of the flashing pedestrian clearance display, e.g., preemption, timing plan change, during a countdown display shall immediately cause blanking of the countdown numerals. The countdown timer shall "re-learn" the pedestrian clearance interval upon return to normal service after preemption or immediately following a change in walk clearance time associated with a timing plan change.

2. Type A2. The top section shall be identical to the 12 inch (300 mm) Type D2 pedestrian signal. The bottom section shall consist of a countdown display in a 12 inch (300 mm) housing.

3. Type D2. The left side of the signal section shall consist of an integral hand/walking person display. The right side compartment shall contain the countdown display.

Furnish materials according to the Department's QPL.

732.06 Pedestrian Pushbuttons. Furnish pushbuttons of sturdy construction that consist of a base housing and a removable cover. Furnish components that provide a pushbutton with normally open contacts and that include all electrical and mechanical parts required for operation.

Ensure that the design of the pushbutton and its associated contacts and housing are sturdy and resistant to mechanical shocks and abuse. Ensure that a concentrated force of 50 pounds (225 N) applied to the button or any exposed portion does not damage the unit or misadjusts the contacts. Furnish a housing with a curved back surface for mounting on poles of various diameters. Integrate the curved surface with the housing or supply an adapter with a flat back type housing. Attach the cover assembly to the housing by stainless steel machine screws, resulting in a weatherproof and shockproof assembly. Furnish a hole threaded for a 1/2-inch (13 mm) pipe in the housing for conduit attachment purposes. Furnish housing with manufacturers applied external surfaces black Color 17038 or yellow Color 13655, Federal Standard 595, unless specified otherwise in the Plans.

The pushbutton shall be a minimum of 2 inches across in at least one dimension. The force required to activate the pushbutton shall be no greater than 3.5 pounds (15.5N) and operate with a closed fist. There shall be a visible and audible indicator that the button press has occurred.

A. Accessible Pedestrian Pushbutton. Use a pushbutton with a tactile arrow with high visual contrast, a continuous locator tone and a speech walk message for the Walking Person indication, and a speech pushbutton information message. Ensure all elements of the pushbutton are programmable and include all equipment necessary to program the pushbutton. Ensure the sign included with the pushbutton is the R10-3e.

Furnish materials according to the Department's TAP List.

732.07 Loop Detector Units.

B. NEMA TS-2. Furnish loop detector units according to NEMA Standards TS-2.

Furnish loop detector unit with an LED or LCD display indication of call strength (ΔL/L or equivalent). This display shall be a bar graph or numerical display with at least eight (8) discrete levels indicated.

Furnish materials according to the Department's TAP List.

C. Type 33x

In addition to the requirements of Caltrans TEES, furnish detector unit with an LED or LCD display indication of call strength (ΔL/L or equivalent). This display

shall be a bar graph or numerical display with at least eight (8) discrete levels indicated.

Furnish loop detector sensors according to the Department's TAP List.

732.11 Signal Supports. Furnish signal poles and mast arms that are tapered tubes of a true continuous taper. Furnish tubes that are circular or regular polygons with twelve or more sides. Ensure that any measurements of circular tube diameter at a specific point along the longitudinal axis do not vary by more than 3/16-inch (5 mm). Ensure that the taper is between 0.54 and 1.3 percent. A rectangular, rounded-corner aluminum Pole Identification Tag with minimum dimensions of 1 x 3 x 0.040 inches shall be attached to the pole at a height of 6 inches above the base plate. The Pole Identification Tag shall be clearly and deeply stamped with the ODOT Standard Construction Drawing Number, Design Number, and the fabrication date of the pole (e.g., TC-81.22, DES. 12, 05-12) in characters with a minimum height of 3/8 in. Attach to the pole with four stainless steel 3/16 inch rivets.

Fabricate mast arms of the true continuous taper type in two portions joined by overlapping of sections with the overlap being at least 1 1/2 diameters as determined by the largest diameter of the outer portion. Assemble the sections with a 5/8-inch (16 mm) minimum stainless steel or galvanized steel hex head through-bolt.

Ensure that there is not more than one longitudinal, automatically electrically welded seam on circular poles. Ensure that the welded seams are neat and uniform in appearance and have a thickness not less than the base material and a bead height not exceeding 1/16-inch (2 mm). Ensure that the wall thickness at each pole or arm cross-section is of uniform thickness, except at weld beads. Do not place transverse seams or welds on true continuous taper type poles or arms. Weld according to 513.21.

After fabrication, hot-dip galvanize poles and arms according to 711.02.

Do not use guy rods or truss-type arms. Furnish poles and mast arms with attachment plates and gussets. Assemble using high-strength bolts with the connection developing the full moment-resisting capability of the arm. Do not allow the butt diameter of mast arms to exceed the nominal diameter of the pole at the point of attachment.

Fit poles with a welded-on cast or plate steel base designed to mount on an anchor bolt foundation and ensure that each pole includes the furnishing of anchor bolts and conduit ells for installation in the foundation. Furnish at least one 2-inch (50 mm) diameter conduit ell for installation in each foundation. Furnish conduit ells made from steel complying with 725.04; however, if they connect to non-metallic conduit, ensure that they are of the same non-metallic material.

Use steel anchor bolts conforming to ASTM F1554, Grade 105 and galvanized according to 711.02. Ensure that ends have a steel plate as shown on the plans.

Ensure that the poles include a handhole near the base oriented as required. Reinforce the handhole with a welded-on steel frame with a grounding lug and fit it with a cover plate fastened by stainless steel screws. Ensure that the poles also include a cable and wire support J-hook welded near the top and a removable pole cap. Design poles and arms so their interiors conceal wiring and their mast arms

include grommeted wire outlets for the signal heads. Furnish hanger clamps with clevises on the mast arms for the signal heads as required. Ensure that arm caps are made of steel and cover at least 50 percent of the end area.

Ensure that signal poles combining provisions for roadway lighting include an additional handhole located opposite the mast arm flange with the poles' J-hook located above.

Furnish pedestrian pushbutton access holes and blind half couplings for controllers and pedestrian signal heads as required. Plug any unused holes.

Furnish certified materials according to Supplement 1094.

732.12 Strain Poles. Furnish signal strain poles for the attachment of span wire that are steel tapered tubes according to the requirements of 732.11. Ensure that all poles include a removable pole cap, and messenger wire clamps with clevis and shackle unless otherwise specified. A rectangular, rounded-corner aluminum Pole Identification Tag with minimum dimensions of 1 x 3 x 0.040 inches shall be attached to the pole at a height of 6 inches above the base plate. The Pole Identification Tag shall be clearly and deeply stamped with the ODOT Standard Construction Drawing Number, Design Number, and the fabrication date of the pole (e.g., TC-81.22, DES. 12, 05-12) in characters with a minimum height of 3/8 in. Attach to the pole with four stainless steel 3/16 inch rivets.

Furnish anchor bolt foundation type strain poles that include a welded-on cast or plate steel base, bolt covers, a handhole, and a J-hook, as required by 732.11, and that also include at least one 2-inch (50 mm) cable entrance with a weatherhead and a welded blind half-coupling. Ensure that the poles include the furnishing of anchor bolts and conduit ells for installation in the foundation. Furnish at least one 2-inch (50 mm) diameter conduit ell for installation in each foundation. Furnish steel conduit ells that comply with 725.04; however, if they connect to non-metallic conduit, ensure that they are of the same non-metallic material.

Furnish certified materials according to Supplement 1094.

732.13 Wood Poles. Furnish wood poles that conform to ANSI 05.1 "Specifications and Dimensions for Wood Poles", that are made of Southern Pine or Western Red Cedar, and that are full-length pressure treated according to 725.19.

732.14 Down Guy Assemblies. Furnish expanding or screw type anchors capable of withstanding a guy tension of 8000 pounds (35 kN) when installed in firm moist soil. Ensure that each anchor rod is 5/8-inch (16 mm) minimum diameter, 8 feet (2.4 m) minimum length galvanized steel with thimble eye.

Ensure that all pole and attachment hardware is hot dip galvanized in accordance with 711.02.

Furnish 3/8-inch (10 mm) minimum diameter guy wire that conforms to 732.18 and ensure that all accessories have a rated loading strength equal to or greater than the messenger wire minimum breaking strength.

Furnish porcelain strain insulators of the wet process type.

Furnish an 8 feet (2.4 m) minimum length guy guard made of impact and ultraviolet light resistant yellow plastic that is fastened to the guy wire.

Furnish materials according to the Department's QPL.

732.15 Pedestals. Fabricate pedestals for the support of traffic control equipment of 4-inch (100 mm) schedule 40 steel or aluminum pipe. Fit the steel pipe with a welded-on base of plate or cast steel, or when specified thread the steel pipe into a gray cast iron transformer type base. Furnish galvanized steel pedestals according to 711.02. Thread aluminum pipe into an aluminum cast transformer type base. Design pedestals to mount on an anchor bolt foundation and include the furnishing of anchor bolts and conduit ells for installation in the foundation.

Furnish materials according to the Department's QPL.

732.16 Conduit Risers. Ensure that risers have conduit and fittings according to 725.04 and the weatherhead is made of aluminum or galvanized ferrous metal and threaded.

732.17 Cable Support Assemblies. Ensure that the cable grip used with cable support assemblies is of the proper size and strength for the cables and is of the flexible "closed" or "split with rod" type, of stainless steel or tin coated bronze, and equipped with a single "U" eye bale. Ensure that the smallest cable grip permitted has a minimum rated breaking strength of 250 pounds (1.1 kN).

Ensure that the slings for cable supports are made from copper clad or galvanized multi-strand steel wire with an overall diameter of not less than 1/8-inch (3 mm) and a breaking strength of at least 400 pounds (1.7 N). Use thimbles to form eyes at each end of the sling with grooves to match the wire. Adjust the sling to the proper length with the wire at each thimble lapped and secured with split bolt clamps.

Furnish materials according to the Department's QPL.

732.18 Messenger Wire

A. Wire. Furnish seven strand ASTM A475 Class B Utilities Grade or stronger messenger wire except 1/4-inch (6 mm) seven strand messenger wire must be High Strength Grade or stronger. Furnish 1/4-inch (6 mm) seven strand ASTM A475 Class B High Strength Grade or stronger tether wire. Furnish all wire per ASTM A475 with the following modifications:

18.2 Tags are not required on lengths less than 1000 feet (300 m).

B. Accessories. For messenger wire ensure all accessories have a rated loading strength equal to or greater than 73 percent of the messenger wire minimum breaking strength. For breakaway tether installations, accessories within the turnbuckle-tensioned portion of the tether span shall have strength equal to or greater than 73 percent of the breaking strength of 1/4-inch, 7-strand ASTM A 475 High Strength Grade Wire rope, or 3460 pounds (15.4 kN). Other portions of the tether assembly shall use accessories strength equal to or exceeding the wire rope used in that portion. S-hooks shall be made of mild low-carbon galvanized steel and of the wire size indicated on the plans; larger wire sizes and higher-strength steel S-hooks shall not be substituted. Safety tie wire shall be 304 or 316 stainless steel, 1×19 stranded, 1/8-inch (3 mm) with stainless steel wire rope clips. If used, lead sheet to wrap tether wire in breakaway anchors shall be commercially pure lead of thickness 0.030 to 0.042 inches (0.75 to 1.0 mm).

Furnish materials according to the Department's QPL.

732.19 Cable and Wire. Furnish cable and wire meeting the requirements of Table 732.19-1 and rated at 600 volts with conductors of copper unless otherwise specified. Ensure that the cable or wire jacket is indelibly marked at intervals of not more than 6 feet (2 m) with nomenclature stating the size, the type, the organization specifying the type, and the manufacturer's name or trademark.

Furnish materials according to the Department's QPL.

TABLE 732.19-1 CABLE AND WIRE

Cable or Wire	Number of Conductors	Wire Gage	Specification or type	Conductor Type	Notes
Signal Cable	As specified	As specified	IMSA 19-1 IMSA 20-1	Copper, color coded, stranded	
Loop detector wire	Single conductor	14 AWG	IMSA 51-5	Copper, stranded	
Loop detector lead-in cable	Two conductor	14 AWG	IMSA 50-2	Copper, twisted pair, stranded, shielded	
Power cable	Two conductor	As specified	UL: RHH/RHW/ USE or HHW, cross linked polyethylene with an insulation thickness of 0.045 inch (1.14 mm) (min.)	Copper, stranded	[3]
Service cable	Two conductor (duplex)	As specified		Aluminum,[1] twisted, stranded	
Ground Wire	Single conductor		UL: RHH/RHW/USE or XHHW, cross linked polyethylene	Copper, stranded	[4]
Loop detector lead-in cable, direct burial	As specified	12 or 14 AWG, or as specified	IMSA 19-6 IMSA 20-6	Copper, stranded	
Loop detector lead-in cable, Integral messenger type	As specified	12 or 14 AWG, or as specified	IMSA 19-4 IMSA 20-4	Copper, stranded	

Notes

[1] Copper conductors may be substituted

[2] ANSI/ICEA Cable shall have: Solid insulations, Full count color coding, 8-mil shield, and 772 kHz attenuation compliance. All other specifications are manufacturer's option unless specified.

[3] Three-conductor cable may be specified. Permitted substitution: 2 (or 3) single conductor cable.

[4] Minimum size is equal to the power or service cable, whichever is larger.

732.20 Power Service. Furnish risers for power service that are 1 to 1 1/2-inch (25 to 38 mm) diameter conduit and fittings according to 725 Furnish weatherheads that are threaded and made of aluminum or galvanized ferrous metal. Include a disconnect switch with enclosure.

732.21 Disconnect Switch with Enclosure. Ensure that the switch enclosure is a UL listed watertight lockable stainless steel NEMA Type 4 supplied with the conduit hubs listed on the enclosure UL label. Furnish an enclosure that contains as a minimum a single-throw, 2 pole, solid neutral, fused safety disconnect switch UL listed as suitable for a service disconnect with a minimum capacity of 30-amperes at 240 VAC. Ensure that the unit can be padlocked in both the "ON" and "OFF" positions.

Furnish materials according to the Department's QPL.

732.22 Backplates. Furnish louvered backplates constructed of wrought sheet aluminum, according to ASTM B 209 (B 209M), 6061-T6, 0.050 inch (1.3 mm) minimum thickness. Louvers shall be at least 8 percent of the total backplate area. Backplate base metal shall be anodized to maximize paint adhesion according to Mil-A-8625, Type II or Type I. Furnish backplates painted on both sides with at least two coats of flat black alkyd enamel paint or polyester powder coat (no epoxy) closely matching FED-STD-595b-37038. Furnish a backplate that extends 5 inches (125 mm) beyond the outside of the signal assembly on all sides. The overall outside shape of the installed backplate shall be rectangular. The backplate shall allow no gaps between the backplate and the signal head or between signal sections. A 2-inch (50 mm) wide continuous outside border of fluorescent yellow reflective sheeting shall be applied to the front of the backplate. Border shall not be applied over the louvers. Reflective sheeting shall be Type J, ASTM D4956 Type XI. Prepare backplate surfaces in accordance with 630.04 prior to applying the reflective material. All assembly and mounting hardware shall be stainless steel conforming to 730.10. If used, machine nuts shall be thread-deforming or nylon locknuts. Rivets shall not be used for mounting the backplate to the signal head. A minimum of four mounting points shall be used on each signal section for attaching the backplate. Furnish all mounting hardware.

733 TRAFFIC SIGNAL CONTROLLER MATERIAL

733.01 References and Definitions.

"ATC" refers to equipment manufactured in conformance with the Advanced Transportation Controller Standard, a joint standard of AASHTO, ITE, and NEMA

"NEMA TS-2," "Type TS-2/A2," and "Type TS-2/A1" refers to equipment manufactured in conformance with the National Electrical Manufacturers Association (NEMA) Standards Publication No. TS-2.

"Type 332" and "Type 336" refers to equipment manufactured in conformance with the California Department of Transportation (CalTrans) specifications titled "Traffic Signal Control Equipment Specifications" and "Transportation Electrical Equipment Specifications", including all addenda.

"Type 2070" refers to equipment manufactured in conformance with the California Department of Transportation (CalTrans) specifications titled "Transportation Electrical Equipment Specifications", including all addenda.

"IP" refers to equipment conforming to the Internet Protocol Suite communication protocols defined by the Internet Engineering Taskforce RFC 1122.

"TAP" refers to the Traffic Authorized Products list for products that have been authorized for use on Intelligent Transportation Systems (ITS) for the Ohio Department of Transportation.

733.03 Cabinet. Ensure that all cabinets comply with the requirements of this Section. Equip all NEMA specified cabinets as follows:

Supply two through four phase controller operation with a minimum twelve position backpanel, configured for four pedestrian movements and four overlaps, with a NEMA TS-2 malfunction management unit.

Supply five through eight phase controller operation with a minimum 12 position backpanel, configured for four pedestrian movements and no overlaps, with a NEMA TS-2 malfunction management unit.

For signal phasing configurations that require a larger capacity backpanel or conflict monitor, supply a 16 position backpanel with a NEMA TS-2 malfunction management unit.

Furnish each cabinet main door with a sturdy, permanently lubricated lock that is covered with a weatherproof tab. Key the project locks to the master key used by the agency that will maintain the equipment. Supply two keys with each lock. Also, equip the small door-in-door with a lock that is keyed to the maintaining agency's master key, covered with a weatherproof tab. The door handle shall swing out away from the door edge, not toward the center of the door.

Any fasteners (rivets, bolts, etc.) that penetrate the cabinet exterior shall be tack-welded or brazed on the inside surface to prevent punch-thru if the fastener head is ground off from the outside. The preferred method of cabinet construction uses no such fasteners, but internal welds only.

Furnish cabinet with drawings that show the following:

1. Intersection map. The map shall include street names, all lanes, crosswalks and stop bars, all vehicle and pedestrian phases, all loops and detection zones, vehicular and pedestrian signal heads, and pedestrian pushbuttons. All of these features shall be labeled. Include a legend that shows the type of vehicular and pedestrian heads and north.

2. Field wiring hook-up chart for all signal heads. The chart shall include signal head name, signal head display indication, and field terminal on back panel.

3. Conflict Monitor/MMU channel assignments and functions, switch positions, and settings. Also show program card jumper locations diagrammatically (if applicable). If the Conflict Monitor/MMU is programmed via methods other than a program card detail this diagrammatically.

4. Legend with all wire gauges and insulator colors used in the cabinet. Apply this legend to all wiring shown in the drawings. Also include components such as MOVs and diodes.

5. Detector panel wiring. Detail all detector landings.

6. All cable and wiring harness pin assignments.

7. Detector rack layout. Label detector number and associated phase.

8. SDLC cable assignments.

9. Pedestrian pushbutton wiring.

10. Load switch assignments.

11. Flash programming buss and field terminals wiring.

12. I/O board, load switch, and flash transfer relay wiring.

13. Any video, radar, preemption, or other device wiring, interface, and cabling details.

14. UPS as-built schematic (if applicable). Detail all connections to cabinet and controller.

15. Netlist detailing all connectivity of the cabinet. It shall include all instances in the cabinet. Provide a description of all instances.

Furnish 60-month warranties or the manufacturers' standard warranty, whichever is greater for the following equipment:

a. ATC/NEMA Cabinet & Equipment

(1) Bus Interface Units

(2) Malfunction Management Units

b. ATC/CalTrans Cabinet & Equipment

(1) Model 2010/2018 Conflict Monitor Units

Ensure that the warranty period begins on the date of shipment to the project. Ensure that each unit has a permanent label or stamp indicating the date of shipment. Label shall indicate the equipment vendor name and or logo

B. Type TS-2.

1. Furnish TS-2 cabinets that utilize a high speed data channel to connect the controller unit, malfunction management unit, rear panel (terminals and facilities), detectors and bus interface units and also comply with the general requirements of 733.03. Furnish a prewired cabinet with malfunction management unit, loop detector units, and all accessory equipment as specified in NEMA TS-2, except as follows:

a. Section 5.3.4, use detector racks for both Type 1 (A1) and Type 2 (A2) controller units.

b. Section 5.4.2.1, if a power service disconnect switch is located before the controller cabinet, the neutral (AC-) and the grounding bar in the controller cabinet shall be connected together.

c. Section 5.4.2.7, provide an LED type light.

d. Section 5.4.2.7.2, provide the LED lamp.

e. Section 5.4.2.7.3, provide the door actuated light switch.

f. Section 6.5.2.2.1, provide 2-channel detector units, without delay/extension features (Type A). Furnish momentary pushbuttons on the cabinet door or a detector rack panel for actuation of Detector BIU #9, channels 1-16, and the four opto-isolated pedestrian detector inputs on BIU #1 and BIU #2. Permanently label these pushbuttons as "VEH DET 1" through "VEH DET 16" and "PED DET 1" through "PED DET 8."

g. Section 7.2, construct cabinets of sheet aluminum.

h. Section 7.3, unless otherwise specified in the plans, provide a Size 5 cabinet for pole mounted cabinets, Size 7 for ground mounted cabinets. Supply larger cabinets if required to house the equipment to meet the plan requirements; such as additional ITS equipment, preemption devices, 16 position backpanels or special detection units.

Furnish all wire passages through and over metal edges with edge protection polymer trim.

i. Section 7.5.7, ensure that the police panel contains switches for AUTO/FLASH, SIGNALS ON/OFF and AUTO/MANUAL in the police panel. Furnish a pushbutton with a 5-foot (1.5 m) cord, and panel connector, not hard wired, unless a strain-relieving panel feed-thru bushing is provided.

j. Section 7.7.3, supply unpainted cabinets.

k. The following overrides the NEMA requirements for signal bus relays. A solid-state relay shall be used for the signal bus relay. This relay shall maintain output equal to or exceeding the requirements of the cabinet main overcurrent protective device over the NEMA TS-2 Environmental Operating Range of -30 to +165 degrees Fahrenheit.

2. Furnish loop detector and pedestrian inputs that have lightning/surge protection.

Furnish loop detector lead-in cable protection that consists of devices installed in each detector circuit where the lead-in connects to the terminal block. House each device in a case that consists of two stages; a 3-electrode gas tube arrestor and a semiconductor circuit. Ensure that the arrestor shunts to ground a common mode transient with a 1,000 ampere peak and an 8/20 microsecond wave-shape, ionizing at 400 volts within 100 nanoseconds when subjected to a 1,000 volt per microsecond transient. Furnish a semiconductor circuit that clamps a differential transient to 30 volts within 40 nanoseconds of the appearance of the transient, and a common mode transient to 30 volts within 500 nanoseconds of the ionization of the gas tube arrestor. Ensure that the second stage is able to withstand a peak current of 13 amperes. Furnish a device that has impedance characteristics compatible with

the detector unit so as not to cause false calls or increase the loop impedance above the sensitivity of the detector unit.

Furnish pedestrian pushbutton inputs with the same protection as specified for the loop detector lead-in cables.

3. Include loop detector racks with the necessary number of two-channel loop detector units with the cabinet. When shown on the plans, supply delay and extension timing capability on the detector unit; otherwise, provide the controller unit software with these features. If vehicle detector types other than "loop" detectors are required by the plans, provide these detector units by separate bid item. If the special bid detector units use standard TS-2 detector racks, furnish the racks as part of the pre-wired cabinet.

Furnish loop detector unit with an LED or LCD display indication of call strength ($\Delta L/L$ or equivalent). This display shall be a bar graph or numerical display with at least eight (8) discrete levels indicated.

4. Furnish switches to control the controller unit and cabinet functions as specified in the plans.

5. Furnish load switches that have both input and output indicators.

6. The primary surge protection device (SPD) shall be an EDCO SHA-1250 or approved equal. A plug-in base shall be used to hold the device. All wiring connections shall be made to the base, and appropriate cabinet clearances maintained, to allow the SPD module to be replaced by hand without the use of tools. Cabinet power distribution shall conform to Figure 5-4, NEMA TS-2 2003 v02.06. In addition, install three (3) non GFCI NEMA 5-15 utility outlets on the right side of the power panel for a total of six (6) receptacles. These outlets shall be powered independently of the UPS by direct connection to incoming utility power through a 15-amp circuit breaker labeled "UTILITY OUTLET."

7. Include serial and/or Ethernet cables, 4-feet minimum length, to interface with laptop computer. Include all interface software.

9. Include an SDLC expansion board with three available ports, mounted on a cabinet side wall.

10. Include an SDLC in-line surge suppressor, EDCO SRS-BIU-15 or equivalent, located at the controller SDLC port.

11. Furnish an aluminum shelf with integral storage compartment in the space immediately below the controller. Ensure the storage compartment has telescoping drawer guides for full extension. Ensure the compartment top has a non-slip plastic laminate attached.

Furnish TS-2 cabinet according to the Department's TAP List.

C. Type 332.

1. General. Furnish Model 332L cabinets that meet the specifications "Traffic Signal Control Equipment Specifications" and "Transportation Electrical Equipment Specifications", California Department of Transportation. Ensure that

the manufacturer of the cabinets is listed on the TAP at the time of delivery to the project.

2. Cabinets.

a. Ensure that the cabinets are constructed of aluminum and are supplied unpainted. An anodic coating is not required. Supply galvanized anchor bolts with nuts and washers with each cabinet. Furnish 3/4-inch (19 mm) diameter by 16 inches (0.4 m) minimum length anchor bolts with an "L" bend on the unthreaded end.

b. Fit the cabinets with a PDA-2 power distribution assembly.

c. When shown on the plans, provide the cabinet with door hinges that are "right" or "left" mounted when facing the front of the cabinet.

d. Use 332L ground mount cabinets that have an auxiliary output file. Ensure the auxiliary output file is in accordance with the Caltrans TEES 2009, Section 6.4.5.3 Output File #2 and come with two flasher blocks and six load switches. Ensure all channels from the output file are monitored by the CMU.

3. Terminals and Wiring.

a. "Hardwire" output files. Do not use printed circuit wiring in the output file except for the red monitor board.

b. Ensure that the vehicle and pedestrian detector field wiring inputs connect to side mounted terminal blocks. Install terminal blocks and associated wiring to the input file. Label the field wiring terminals of the side mounted terminal block by a permanent screening process to identify the input panel (I or J), the input file slot number (1 through 14) and the channel terminal (D, E, J, or K). An example is "I4-E". Ensure that all terminals on these detector blocks are accessible without removing equipment from the EIA mounting rack.

c. Install red monitor cabling in the cabinets. Install a program board to enable/disable red monitoring. Ship the cabinets with the red monitor jumpers set in the "enable" position.

d. Do not connect the pedestrian yellow load switch outputs to the conflict monitor card-edge connector.

e. Supply each cabinet with a cable at least 5 feet (1.5 m) long to connect a laptop computer with the controller. Ensure that the cable has a DB-9 connector on one end, and a connector on the other end to mate with the C2 on the back of the controller. The cable will allow a laptop computer to upload/download data to the controller.

f. Supply each cabinet with a Category 5e cable with 8P8C (RJ45) plug on each end, minimum 5 feet in length. The cable will allow a laptop computer to upload/download data to the controller.

g. On the output file, wire pin No. 11 of each switchpack connector to AC- so that the output indicators on dual indicator switchpacks will display properly.

4. Accessories.

a. Fully equip the cabinets with two channel loop detector sensors, flashers, flash transfer relays, power supply, AC and DC isolators, conflict monitor, switchpacks (with both input and output indicators), and a DC isolator in slot 14 for flash sense/stop time. Do not switch the input file channels from the standard layout in order to minimize the number of two-channel detector units utilized. If vehicle detector types other than "loop" detectors are required by the plans, provide these detectors under a separate bid item.

Flash Transfer Relays shall use AC coils only; the use of a series rectifier in combination with a DC coil is prohibited.

In addition to the requirements of Caltrans TEES, furnish detector unit with an LED or LCD display indication of call strength ($\Delta L/L$ or equivalent). This display shall be a bar graph or numerical display with at least eight (8) discrete levels indicated.

Furnish loop detector sensors according to the Department's TAP List.

b. Furnish a rack mounted detector test panel with test switches. Test switches shall call vehicle phases 1-8, pedestrian phases 2,4,6,8 and EVPE channels A,B,C,D as defined in the published ODOT Plan Insert Sheet for default 332/336 cabinet input file assignments. Furnish switches with three position "on/off/momentary on" switches.

c. Furnish a police panel in each cabinet that includes a removable pushbutton with 5 feet (1.5 m) cord and three switches labeled AUTO/FLASH, SIGNALS ON/OFF and AUTO/MANUAL. Wire the pushbutton cord to the controller harness wiring by a molex plug connection and not through an AC isolator. When placed in the manual position, apply "manual control enable" to the controller and apply "recall" to all phases. Ensure that activation of the push button "advances" the controller, except prohibit the manual advancement during the minimum green, yellow, and red timing intervals.

d. Furnish an aluminum shelf with integral storage compartment in the rack below the controller. Ensure that the storage compartment has telescoping drawer guides for full extension. Ensure that the compartment top has a non-slip plastic laminate attached. Top of shelf shall be at least 30 inches and no more than 48 inches above the workpad surface. For cabinets with risers, this may require relocating the drawer to a position below Input File #2.

e. Ensure that each cabinet has two white LED lights installed at the top of the cabinet, one near each door. Wire the lights to the door switches such that opening either door will turn on both lights.

5. Surge Protection.

a. Furnish surge protection on pedestrian and detector inputs. Furnish three terminal surrestors equivalent to EDCO models SRA-6LCA, SRA-6LCB, or SRA-6LC.

b. Protect the cabinet's incoming power lines with an EDCO SHA1250 or approved equal surge protector in lieu of the CalTrans specified surge protection. A plug-in base shall be used to hold the device. All wiring connections

shall be made to the base, and appropriate cabinet clearances maintained, to allow the SPD module to be relaced by hand without the use of tools.

6. Conflict Monitor. Ensure that the conflict monitor unit was tested and accepted according to Supplement 1076.

a. Materials and Warranties. Furnish electrical parts, switches, and other elements of the installation that are of ample capacity to carry the required current without excessive heating or drop of potential.

Use standard industrial quality components (integrated circuit chips, transistors, diodes, resistors, capacitors, etc.) wherever possible. Clearly identify these components with the original identification. Designate the other vital information such as voltage polarity, emitter or collector terminals, pin locations, etc., by an approved industrial procedure. Ensure that the major items or assemblies of equipment bear a nameplate, indelible marking, or brand that identifies it as to type, model, catalog number, and manufacturer.

Transfer that manufacturers' guarantees or warranties to the Department upon delivery and acceptance of the equipment. Ensure that all conflict monitors are warranted for a period of 60 months or for the manufacturer's standard warranty period, whichever is greater, for parts and labor from date of shipment to the project or the ODOT Signal Shop. Ensure that each unit has a permanent label or stamp indicating the date of shipment and name of vendor supplying the unit and/or logo..

b. General Requirements.

(1) Minimum Standards. This specification establishes minimum standards for Conflict Monitoring Devices designed for use in Model 332 and 336 Traffic Signal Controller Cabinets supplied to the Department.

(2) Indicator Lights. Furnish indicator lights that are water-clear (not colored or diffused lenses), ultra- bright light emitting diodes (LED), whose states are clearly readable in direct sunlight. Ensure that each conflict monitor channel provides separate red, yellow, and green LEDs.

(a) Furnish a GREEN AC POWER indicator light.

(b) Arrange indicator lights in a vertical pattern with FAULT status lights as the upper indications and the output channel lights as the lower indications [See 733.03.C.6.c.(1) and 733.03.C.6.c.(9)]. An acceptable alternative is to provide a single fault indication and a supplemental display that clearly indicates the fault type.

(c) Ensure that a failure causes its respective indicator light to display.

(3) Monitor Power. Ensure that the Monitor does not use the 24VDC power supply being sensed to run any of its internal circuitry. Ensure that the watchdog, stop time, external reset, and 24VDC monitor input circuits are optically isolated from the Monitor internal power supply and are conditioned to provide proper sense circuit operation throughout the operating range.

(4) Power Fail. Consider a line voltage less than 85 V ac ± 2 V ac as a power failure. Ensure that a power failure does not result in resetting the Monitor. Ensure that once the Monitor is triggered by detection of a fault that it remains in that state until a Reset Command is issued. Reset is issued only by the Front Panel Control Switch or by the External Test Reset input.

(5) Power Up. Furnish a Monitor that is compatible with the Model 2070 controller unit. When power is established, > 103 ± 2 Vac, the monitor will power up in the FAULT RELAY RECOVERY mode:

When power is established, initiate FAULT RELAY RECOVERY. For an interval of 6.0 ± 0.5 seconds, the following will take place:

(a) The Output Relay contacts remain closed, and the Stop Time output remains active.

(b) All fault monitoring functions remain suspended.

(c) The AC POWER indicator light flashes at a 2 hertz rate.

At the end of this time interval, the Monitor begins counting Watchdog transitions from the controller and prepares to resume normal fault monitoring.

Ensure that the resumption of normal Fault monitoring occurs when either:

(a) The Monitor has counted 5 transitions between the True and False state from the controller Watchdog; or

(b) 10 ± 0.5 seconds has elapsed from the time of LINE RECOVERY.

If the controller Watchdog output does not become active, ensure that the Monitor goes into a Latched Fault condition.

(6) Cabinet Signals Monitored. Furnish a Monitor designed to monitor Green, Yellow, and Red AC circuits at the field output terminals of traffic signal cabinets. Monitor shall be capable of monitoring Flashing Yellow Arrow channels. In addition, monitor the cabinet 24VDC supply, and the Model 2070 controller Watchdog Timer output. These signals are processed by the Monitor circuitry, and if a failure is determined to have occurred, ensure that a relay output contact closure (FAILED state) places the cabinet and intersection into flashing operation.

(7) Failed State Output Circuits.

(a) Use an electro-mechanical relay to provide the FAILED STATE output circuit. Ensure that the relay contacts are normally closed (FAILED STATE). In a NON-FAILED state (relay coil energized), ensure that the contacts are open. The function of this output circuit is to initiate flash operation within the cabinet and transfer field circuits from the switch pack outputs to the flash bus during a FAILED STATE.

(b) Furnish relay contacts that are rated for a minimum of 3 amperes at 120 V ac and 100,000 operations. Ensure that the contact

opening/closing time is 30 ms or less. Furnish contacts that present a minimum impedance of 50,000 ohms in the open state.

(c) Ensure that the Stop Time output is active whenever the output relay contacts are in the FAILED STATE (closed). Ensure that it is inactive whenever the output relay contacts are in the NON-FAILED (open) STATE.

(8) Monitor Unit Reset. Furnish a front panel momentary SPST pushbutton switch labeled "RESET" to reset the Monitor to a Non-FAILED state and restores normal monitoring operation. Position the switch on the front panel so that the switch can be operated while gripping the front panel handle.

Ensure that the External Test Reset input line resets the Monitor circuitry to a Non-FAILED state and restores normal monitoring operation. Optically isolate it from the internal circuitry. Ensure that a reset issuance by either source (Unit Reset) is triggered by only the leading edge of the input signal (this will prevent a constant reset due to either a switch failure or a constant external input). Ensure that a constant reset input is ignored within 5 seconds of issuance.

(9) Input Impedance. Ensure that the input impedance for all monitored AC inputs are 200 kilohms ± 100 kilohms.

(10) Connectors. Furnish PCB 28/56P Type Monitor and Conflict Program Card Connectors. Ensure that all edge connectors use the "bifurcated bellow" type contact or equivalent.

(11) Door Ajar Circuit. Connect pin 24 to pin 25 on the Monitor PCB at the edge connector and ensure that it is capable of carrying one ampere according to CalTrans specifications.

(12) Handle. Ensure that the handle placement and design is such that no interference between the handle and a closed cabinet door exists.

(13) Fuse Holder. Furnish low profile fuse holders on the front panel.

c. Functional Requirements.

(1) General. The Monitor monitors the cabinet for conflicts and unsafe operation. If an unsafe condition exists, the Monitor will enter into a FAILED state. This places the cabinet into flash operation and applies STOP TIME to the controller unit. Ensure that the Monitor is designed to monitor red circuits, yellow timing, multiple outputs, and lack of outputs on a switch selectable, per channel basis. Specific conditions for failure follow:

(a) 24VDC FAIL. The cabinet +24 volts DC does not meet the specified thresholds.

(b) CONFLICT. When the green or yellow input to one or more channels is ON and they are not programmed as permissive on the Conflict Program Card.

(c) WATCHDOG TIMER (WDT) ERROR. When the 2070 controller unit watchdog output has ceased.

(d) CONFLICT PROGRAM CARD AJAR. Illuminates, if the Conflict Program Card is removed or if it is not properly seated in the connector. When it is not inserted into the monitor, ensure that the warning indicator light is displayed.

(e) MONITOR FAILURE. A fault is detected within the operation of the monitor itself.

(f) MULTIPLE OUTPUTS. Simultaneous indications of Green, Yellow, or Red field outputs on a single channel.

(g) RED FAIL. No active field outputs on a single channel (green/yellow/red).

(h) YELLOW ERROR. The absence of a minimum yellow field output during a green to red sequence. Minimum yellow shall be 2.7 seconds ± 100 ms.

(2) Operating Range. Furnish a Monitor Unit that is fully operational using an 85 to 135 V ac power source. Ensure that the Monitor suspends Fault monitoring below 85 V ac ± 2 V ac, closes the output relay, and de-energizes the AC POWER indicator light.

(3) Watchdog Timing. Furnish WATCHDOG Timing Circuitry to monitor the controller unit WATCHDOG output. Ensure that the WDT Circuitry senses state changes and the time between the last change. Ensure that an absence of change for 1.5±0.1 seconds places the Monitor in a FAILED state.

(4) Channels Monitored. Furnish a Monitor that senses and responds to conflicts and 24 VDC failures whenever the AC line voltage is within the 85 to 135 V ac operating range of the Monitor, except during FAULT RELAY OPERATION.

(5) Yellow Inhibit. Furnish means to selectively inhibit the monitoring of a Yellow channel input.

(6) Power Fail after Fault. In the event that the Monitor senses a fault, followed by a loss of operating voltage, ensure that the initial Failure Status is retained in memory and is redisplayed after restoration of power.

(a) Once the Monitor is LATCHED in a fault condition for any reason, including the removal of the Conflict Program Card, ensure that it REMAINS LATCHED, even through a power fail/recovery, until a RESET is issued by the front panel reset switch, or by the external test reset line.

(b) Display the status of the Green, Yellow, and Red inputs of all channels, at the time the fault was latched. Ensure that a power loss does not affect the retention of this data. An acceptable alternative is to save status of all channels in memory and only display the latched fault.

(7) Insertion/Removal of Unit. Ensure that it is possible to insert and remove the Monitor while the cabinet is energized without placing the cabinet into Flash operation provided that: The cabinet door remains open and the

reset switch is held depressed while the unit is being inserted or removed. Any momentary disruption of field signal indications is less than 500 ms.

(8) Microprocessor Use. If a microprocessor is used in the Monitor design, ensure that its program is written so that:

(a) Integrity tests are performed periodically on each memory cell of each memory device, relevant to each device type.

(b) Hardware external to the microprocessor circuits is employed to constantly sense proper microprocessor operation.

(c) The Monitor reverts to a FAILED state if a fault is detected with the microprocessor or during integrity tests.

(9) Front Panel Indicators. Ensure that the Monitor has red/yellow/green indicators for channel inputs and indicators to provide status and failure detection information. Furnish a GREEN AC POWER indicator. Ensure that all indicators are clearly readable in direct sunlight. Arrange and label the indicators as shown below:

(a) AC POWER. Illuminates when the incoming AC Line Voltage exceeds 103 ± 2V ac, and FLASHES during FAULT RELAY OPERATION.

(b) VDC FAIL. Illuminates when the Monitor has detected a 24VDC failure.

(c) CONFLICT. Illuminates when a conflicting signal condition is detected.

(d) WDT ERROR. Illuminates when a Watchdog error is detected. Do not provide a switch or similar device to disable WDT monitoring.

(e) PC AJAR. Illuminates when the Conflict Program Card is removed or is not properly seated in its connector.

(f) MON FAIL. Illuminates to indicate an internal Monitor failure.

(g) RED FAIL. Illuminates when the Monitor detects that there is no active output on any of the field outputs that comprise a monitored channel. Ensure that the failed channels are displayed on the corresponding channel indicators. If for any reason red fail is not enabled, ensure that the red fail indicator light flashes at approximately 2hertz.

(h) MULT IND. Illuminates when the Monitor detects simultaneous outputs on more than one of the field outputs that comprise a monitored channel (green/yellow/red). Ensure that the failed channels are displayed on the corresponding channel indicators.

(i) YELLOW. Illuminates when the Monitor detects the absence of a minimum period of active yellow field output during a green to red sequence. Ensure that the failed channel is displayed on the corresponding channel indicator.

(j) 1, 2, 3, 48. Furnish channel indicators that illuminate a FAILED state in conformance with 733.03.C.6.c.(6).

(10) Monitor Board Edge Connector. Furnish monitor board edge connectors that conform to CalTrans specifications.

(11) Monitoring of Conflicting Voltages. Ensure that inputs to any channel that exceed the specified conflict threshold (see Section 6) are sensed as "ON" and illuminate their respective channel indicators. Ensure that the number of active channels in no way affects the conflict threshold.

Ensure that the following voltage levels and times apply: A conflict has occurred and will cause a FAILED state only when voltages appear at the field output terminals.

> 20 ± 5.0 V rms for a duration > 350 ± 150 ms.

(12) Conflict Program Card. Furnish conflict program cards that comply with CalTrans specifications.

d. Fault Relay Operation.

(1) Line Drop Out. Furnish a Monitor that determines that a LINE DROP OUT has occurred when:

The AC Line Voltage is:

< 98 ± 2 VAC for > 400 ± 100 ms.

Within this time frame, ensure that the Monitor suspends all fault monitoring functions, closes the output relay contacts, enables Stop Time output, and the AC POWER indicator on the front panel flashes at a rate of 2 hertz ±20 percent to indicate LINE DROP OUT status. Ensure that the Monitor remains in the FAULT RELAY mode until a LINE RECOVERY has occurred.

(2) Line Recovery. Ensure that the Monitor that determines that a LINE RECOVERY has occurred when:

The AC Line Voltage is:

> 103 ± 2 VAC for > 400 ± 100 ms.

(3) Fault Relay Recovery. When LINE RECOVERY is established, initiate the FAULT RELAY RECOVERY. For an interval of 6.0 ± 0.5 seconds, the following will take place:

(a) The Output Relay contacts remain closed, and the Stop Time output remains active.

(b) All fault monitoring functions remain suspended.

(c) The AC POWER indicator light flashes at a rate of 2 hertz ± 20 percent.

At the end of this time interval the Monitor begins counting Watchdog transitions from the controller and prepares to resume normal fault monitoring.

(4) Resumption of Normal Monitoring. Ensure that the resumption of normal Fault Monitoring occurs when either:

(a) the Monitor has counted five transitions between the True and False state from the controller Watchdog; or

(b) 10 ± 0.5 seconds has elapsed from the time of LINE RECOVERY.

If the controller Watchdog output does not become active, the Monitor shall go into a Latched Fault condition.

e. Red Monitoring Connector.

(1) Connector. Mount a connector, 3M-3428-5302, with two 3518 polarizing keys, or equivalent, on the Monitor front panel. The pin assignments of the P20 connector and terminal assembly are defined in this specification.

Ensure that it is possible to plug and unplug the Red Monitoring Connector P20 without placing the cabinet into Flash operation.

P20 CONNECTOR PIN ASSIGNMENTS

Pin	Function	Pin	Function
1	CHANNEL 15 RED	2	CHANNEL 16 RED
3	CHANNEL 14 RED	4	UNDEFINED
5	CHANNEL 13 RED	6	SPECIAL FUNCTION 2
7	CHANNEL 12 RED	8	SPECIAL FUNCTION 1
9	CHANNEL 10 RED	10	CHANNEL 11 RED
11	CHANNEL 9 RED	12	CHANNEL 8 RED
13	CHANNEL 7 RED	14	CHANNEL 6 RED
15	CHANNEL 5 RED	16	CHANNEL 4 RED
17	CHANNEL 3 RED	18	CHANNEL 2 RED
19	CHANNEL 1 RED	20	RED ENABLE

Ensure that keying is between pins 3/5, and 17/19. The odd numbered pins are on one side, and the even pins are on the other. Key the P20 connector and the CMU connector physically alike (to prevent the Red Monitoring cable from being inserted into the P20 180 degrees out of alignment).

(2) Red Enable Input. Ensure that pin 20 of the Red Monitoring Connector provides the Red Enable input to the Monitor. When the Red Monitoring Connector is disconnected, or Red Enable is not present, ensure that the Monitor checks for conflicting combinations of Greens and Yellows, Watchdog Timer, 24VDC, Conflict Program Card Ajar, and Monitor Fail. When enabled, ensure that the extended Monitor functions become active including: Red Fail, Multiple Output, and Yellow Fail.

(3) Special Function 1 and 2 Inputs.

(a) PIN 8, Special Function 1: Furnish an AC input to the Monitor, which will DISABLE only the RED FAIL monitoring functions while it is active (e.g. during Railroad Preempt).

(b) PIN 6, Special Function 2: Reserved for future use.

Furnish a means to select either a PRESENCE of, or LACK of AC+ to enable these inputs.

f. Electrical Requirements.

(1) Operation Range. Furnish a Monitor that is fully operational from an 85 to 135 V ac power source.

(2) Isolation. Isolate the Chassis Ground and AC - from one another.

(3) Monitored AC Inputs. The following voltage and time thresholds apply to all monitored AC inputs.

(a) Green and Yellow Inputs.

Any inputs < 15.0 V rms are considered OFF.
Any inputs > 25.0 V rms are considered ON.

Both sinusoidal and half-wave inputs of the specified RMS values are to meet these thresholds.

(b) Red, Red Enable, and Special Function Inputs.

Any inputs < 50.0 V rms are considered OFF.
Any inputs > 70.0 V rms are considered ON.

Red inputs, both sinusoidal, and half-wave, of the specified RMS values, are to meet these thresholds.

Red enable and special function inputs are to meet these thresholds for sinusoidal waveforms only.

(c) Timing of Conflicting Inputs or Multiple Inputs.

Inputs ON < 200 ms are **NOT** considered a FAULT.
Inputs ON > 500 ms are considered a FAULT.

(d) Timing of Red Fail.

Lack of output < 1200 ms is **NOT** considered a FAULT.
Lack of output > 1500 ms is considered a FAULT.

(4) Monitored DC Inputs.

(a) 24VDC Input.

Input < 18.0 VDC is considered Low VDC input.
Input > 22.0 VDC is **NOT** considered Low VDC input.

(b) 24VDC Timing.

Low VDC input < 200 ms is **NOT** considered a FAULT.
Low VDC input > 500 ms is considered a FAULT.

(c) Watchdog Monitor Input.

Input < 4.0 VDC is considered a LOW STATE.
Input > 12.0 VDC (or OPEN) is considered a HIGH STATE.

(d) Watchdog Error Timing.

Lack of valid input state changes for < 1400 ms is **NOT** a FAULT.
Lack of valid input state changes for > 1600 ms is a FAULT.

g. Communications and Software.

(1) Install an RS232 port for laptop communications on the front panel of the Monitor. If specified in the plans, an ethernet port shall be used in place of RS232.

(2) Furnish a Monitor with compatible communications software for installation on a laptop computer, capable of interfacing with the communication port on the front panel. Furnish the software on a 3 1/2-inch (85 mm) floppy disk with each Monitor. Label each disk with revision number and date.

(3) Unless specified otherwise in the plans, furnish a Monitor that is capable of being programmed and set-up for intersection operation without the use of a laptop computer and communication software.

(4) Furnish a Monitor communications software that is capable of showing and/or programming the status of all programmable set-up parameters of the unit. Furnish a communications software that is capable of displaying the following data:

(a) Fault type

(b) Field status (must update status continuously)

(c) AC line voltage (must update status continuously)

(d) Status of Red Enable

(e) Previous fault data

(f) Program card matrix

(g) Yellow disable jumpers (if applicable)

(h) Switch settings per channel (as applicable)

(i) Option switches

(j) Current time

(k) Temperature (must update status continuously)

(l) Event logs

(5) Furnish a Monitor that is capable of storing events into memory. Typical events are fault events, AC line events, reset events, etc. When a fault event is stored into memory, the Monitor will store the fault condition (type), channel status, date, time, temperature, and line voltage. Ensure that the log history stores a minimum of 100 total events.

h. Diode Matrix, Programming Key, and Software. Furnish a Monitor that loads the diode matrix or Programming Key programming into a non-volatile memory device. When the diode matrix or Programming Key is loaded into memory, the memory will regularly compare with diode card or Programming Key and fault condition will occur if memory does not match the diode card matrix.

D. Type 336L.

1. General. Furnish Model 336L cabinets that meet the basic cabinet specifications "Traffic Signal Control Equipment Specifications", California Department of Transportation, latest edition. Ensure that the manufacturer of these Model 336L cabinets is listed on the TAP List.

2. Cabinets.

a. Furnish cabinets that are constructed of aluminum and are supplied unpainted. An anodic coating is not required.

b. The CalTrans Model 336L cabinet specification is only modified so that the cabinet supplied is the "stretch" type that provides approximately 10 inches of (250 mm) additional cabinet height.

c. Supply galvanized anchor bolts with nuts and washers with each base mounted cabinet. Furnish 3/4-inch (19 mm) diameter by 16 inches (0.4 m) minimum length anchor bolts with an "L" bend on the unthreaded end.

d. Furnish pole mounted cabinets with two pole mounting brackets attached and bottom plates installed. Ensure that both of the cabinet sidewalls are reinforced for pole brackets; however, also ensure that the cabinet is shipped with the brackets installed on the door hinge side of the cabinet. When a pole mounted cabinet is ordered, ensure that the door hinges are specified as "right" or "left" mounted as looking into the front of the cabinet. Ensure that the brackets are designed for banding to a pole.

e. Fit cabinets with a PDA-2 power distribution assembly.

3. Terminals and Wiring. Comply with the requirements of 733.03.C.3.

4. Accessories. Comply with the requirements of 733.03.C.4. Furnish materials according to the Department's TAP List.

5. Lightning/Surge Protection. Comply with the requirements of 733.03.C.5.

6. Conflict Monitor. Comply with the requirements of 733.03.C.6.

Furnish 336L cabinet materials according to the Department's TAP List.

733.04 Cabinet Risers. Furnish the type (size and shape) of cabinet riser that is compatible with the type of controller cabinets specified for the project.

A. Cabinet Riser for NEMA Cabinet. Furnish an aluminum riser that will raise the NEMA cabinet approximately 12 inches (0.3 m) above the concrete foundation. Ensure that the bottom of the riser bolts to the standard cabinet foundation anchor bolts (not included with the riser) and the top of the riser bolts to the bottom of the cabinet. Furnish attachment hardware for connecting the riser to the cabinet.

Construct the riser in a minimum of two pieces such that an existing cabinet can be raised off the foundation without disconnecting the field wiring and the riser can be inserted below the cabinet. Furnish hardware for rigidly connecting the riser sections together.

Fabricate the riser from 0.125-inch (3 mm) sheet aluminum with flanges on the top and bottom to provide rigidity. Furnish mounting flanges as necessary to connect with the controller cabinet and foundation anchor bolts. Ensure that the outside surface of the riser has a smooth, uniform, natural finish unless controller cabinet painting is shown on the plans. If painting is required, prepare and paint the riser to match the cabinet.

B. Cabinet Riser for Type 332, 334 or Type 336 Cabinet. Furnish an aluminum riser that will raise the Model 332, 334 or 336 cabinet approximately 8 inches (0.2 m) above the concrete foundation. Ensure that the bottom of the riser bolts to the standard cabinet foundation anchor bolts (not included with the riser) and the top of the riser bolts to the bottom of the cabinet. Furnish attachment hardware for connecting the riser to the cabinet. Manufacture the unit to CalTrans specifications. Ensure that the outside surface of the riser has a smooth, uniform, natural finish unless controller cabinet painting is shown on the plans. If painting is required, prepare and paint the riser to match the cabinet.

Furnish materials according to the Department's QPL.

733.05 Flasher Controller. Furnish solid-state flasher that complies with NEMA TS-2, and have two circuits, each rated at 10 amperes. Furnish a cabinet that conforms to applicable requirements of 733.03.B, except that the following items are not required: a small door-in-door (police door), shelves, and a fan. Ensure that the cabinet size is not less than 12 inches (300 mm) high by 10 inches (250 mm) wide by 6 inches (150 mm) deep. Furnish cabinets that are designed for pole mounting with a 1-1/2 inch (38 mm) or larger conduit opening in the bottom. Ensure that the auxiliary equipment includes: on-off power switch with integral 20-ampere circuit breaker, lightning protection devices on incoming power lines, interference filters, terminal blocks, and a ground bus bar.

Furnish materials according to the Department's QPL.

733.07 Remote Monitoring Station.

A. Description. The Remote Monitoring Station describes a distributive processing, traffic responsive, control and monitoring "closed loop" system. The system monitors, in real time, local intersection activities, and overall system performance, reporting failures and status conditions both automatically and by operator request. In order to meet current and future traffic control needs, the system

also provides extensive control monitoring, data collection, reporting, and analysis functions.

For complete user flexibility, the system provides full access of each local system intersection controller from the Remote Monitoring Station site. Full access includes the capability to upload all time settings, operation parameters, and status information, as well as the capability to download all time settings and operation parameters.

B. System Architecture. The system consists of four principal elements:

1. Local intersection controller (see Supplemental Specification 809.10.G)
2. Communication links
3. Traffic responsive master controller (see 733.06)
4. A Remote Monitoring Station consisting of computer equipment and software

C. Local Intersection Controllers. Furnish controller units conforming to Supplemental Specification 809.10.G for the type of controller shown on the plans. Furnish a controller that has internal communication capability compatible with the type of interconnect cable shown on the plans. Furnish a local system controller that is capable of processing controller and detector data and provide all necessary intersection control functions.

D. Communications. Ensure that communication between the Remote Monitoring Station and the master controller is provided. Furnish communications at the Remote Monitoring Station site by the maintaining agency, unless otherwise shown on the plans.

Include error checking in the software to assure transmission and reception of valid data between the local controller, master controller, and the Remote Monitoring Station.

E. Equipment. Ensure that the Equipment provided at each Remote Monitoring Station location is as shown on the plans and, as a minimum, consists of the following items:

1. Computer with monitor
2. Software
3. Communications
4. Accessory Items

F. System Functional Requirements. The system software provides a simplified user friendly, color menu format at the Remote Monitoring Station. Ensure that no special computer programming skills are required for the user to fully access and operate this control and monitoring system.

1. Graphical Representation. Furnish system software that enables the operator to display in color, the vehicular signals, pedestrian signals, and detector actuations in a real time mode. Ensure that the user is able to construct an intersection layout graphically by using predetermined intersection shapes.

2. System Capacity. Furnish a Remote Monitoring Station software that has the capacity to monitor and control at least 24 traffic responsive masters. Ensure that the central software is also capable of monitoring and controlling isolated system controllers.

Furnish a system software that has the capability to manually select any timing plan, free mode or flash mode.

Ensure that the system software has the capability of accepting, formatting, and processing data from at least 32 system detectors from each master controller.

3. Data Transfer. Ensure that it is possible to upload/download the signal timing database, including coordination, and preemption settings, between the Remote Monitoring Station and the master controller or local intersection.

Furnish a Remote Monitoring Station that provides a means to compare a currently uploaded timing database with a previously developed database stored in the Remote Monitoring Station memory. Ensure that it reports differences in the databases.

During either uploading or downloading operations, ensure that the normal traffic control operations are not suspended.

4. Security. Furnish a Remote Monitoring Station that provides for a user specified security code before any data is altered. Maintain controller access procedures from the Remote Monitoring Station allowing the user full security control of all system components from a remote location.

5. Isolated Intersection Management. Furnish a Remote Monitoring Station software that includes the capability of accessing system controllers at remote intersection locations. Ensure that this capability includes total access to controller timing parameters, alarm conditions, detector data, and intersection status conditions in real time without the use of a master controller. Ensure that this feature utilizes the local intersection controller with a dial-up modem and telephone service.

733.09 Uninterruptible Power Supply(UPS).

A. Operation. In addition to the material requirements below, furnish a UPS system with a minimum two and one half (2.5) hours of full run-time operation for an "LED-only" intersection with 1000 watts of active output power.

Furnish a UPS compatible with all of the following traffic signal equipment; NEMA TS-2 controllers and cabinets, Model 332 & 336 cabinets, 2070 controller and electrical service pedestals.

The maximum transfer time allowed, from disruption of normal utility line voltage to stabilized inverter line voltage from batteries, shall be 65 milliseconds or less. The same maximum allowable transfer time shall also apply when switching from inverter line voltage to utility line voltage.

Include a means to switch the intersection from full-operation to flashing operation after 2-hours of run-time. This is to conserve battery operation during an extended utility power outage.

Include standard form C relay contacts to trigger an alarm within the controller assembly, informing a technician the system is operating on battery backup.

Operating temperature for both the inverter/charger, power transfer relay and manual bypass switch shall be -35 °F to +165 °F (-37 °C to +74 °C).

Both the power transfer relay and manual bypass switch shall be rated at 240VAC/30 amps, minimum.

The UPS shall bypass the utility line power whenever the utility line voltage is outside the following voltage range: 100VAC to 130 VAC, + 2 VAC.

When utilizing battery power, the UPS output voltage shall be between 110 VAC and 125 VAC, pure sine wave output, 60Hz ± 3Hz.

When the utility line power has been restored between 100 VAC and 130 VAC for more than 30 seconds, the UPS shall dropout of battery backup mode and return to utility line mode.

In the event of inverter/charger failure, battery failure or complete battery discharge, the power transfer relay shall revert to the NC (and energized) state, where utility line power is connected to the cabinet.

Recharge time for the battery, from "protective low-cutoff" to 80% or more of full battery charge capacity, shall not exceed 10 hours.

Include all necessary wiring and hardware for mounting (shelf angles, rack, etc).

Furnish a UPS with available buck/boost mode operation, with a minimum input voltage range of 85 to 150 vrms. The unit display shall indicate when buck/boost mode is engaged. Default buck/boost setpoints shall be 108 vrms and 132 vrms unless specified otherwise in the Plans.

Furnish a UPS with an Ethernet port for remote monitoring and control. Provide interface software unless the Ethernet port has built-in web browser compatibility. Remote communication shall have the ability to make setting changes, review status, retrieve alarm and event logging that is time and date stamped for up to 50 events. The logs shall be printable.

Ensure the UPS cabinet has a mastic tape, neoprene foam, or silicone weather-resistant seal between the cabinet bottom flange and the concrete foundation. Minimum tape thickness shall be 1/8-inch (3 mm) and the tape shall be continuous with no gaps between tape pieces or between cabinet and foundation. Sealing tape shall completely cover the bottom cabinet flange and shall be rated for a temperature range of at least -30 °F to +140° F.

The UPS output notifications for on battery, battery 2 hour timer and low battery shall be wired into the traffic signal back panel to provide special status alarms for each output into the signal controller.

This item shall include a red LED status indicator lamp to allow maintenance personnel and law enforcement to quickly assess whether a traffic signal cabinet is being powered by a UPS. The LED housing shall be NEMA 4X, IP65 or IR66, rated for outdoor use and be tamper/shatter resistant. It shall be a domed enclosure

contained a red lens with LED that is visible from 100 foot minimum. The enclosure and LED lamp unit should be placed and centered on the top surface of the UPS cabinet and sealed from water intrusion. It should be wired using minimum 20 GA stranded, insulated hookup wire to the status relay outputs of the UPS.

The wires shall be terminated by lugs at the display end and permanently labeled "Backup Power Status Display," with wire polarity indicated. The red LED shall only illuminate to indicate the cabinet is operating under UPS backup power (the "backup" operating condition). This item also includes programming the UPS status relay outputs to produce the lamp status displays. These status displays will be solid 100% duty cycle (not flashing) displays. The operating voltage of the LED lamp shall be 120V AC unless otherwise indicated.

B. Maintenance, Displays, Controls and Diagnostics. Furnish a UPS with a backlit LCD display that includes an event counter, hour meter, line and battery voltages/percentages and fault status. The LCD display shall have touch keys for changing display statuses and to reset counters, hour meter date and time.

Furnish a UPS with lightning surge protection compliant with IEEE/ANSI C.62.41.

Furnish two (2) sets of equipment lists, operation and maintenance manuals, and board-level schematic and wiring diagrams of the UPS, and the battery data sheets. Manual shall conform to TEES 1999, Chapter 1 Section 1.2.4.2.

C. Battery System. Supply a minimum of four (4) batteries with the UPS system. Each battery shall be 12VDC and be rated at a minimum of 105 Ahrs, 20-hour discharge rate to 1.8 volts/cell at 77 degrees Fahrenheit (25 degrees Celsius), to achieve the 2.5 hour run time requirement. Furnish batteries easily replaced and commercially available off the shelf.

Furnish deep cycle, sealed prismatic lead-calcium based AGM/VRLA (Absorbed Glass Mat/ Valve Regulated Lead Acid) batteries.

Furnish batteries certified in writing by the manufacturer to operate over a temperature range of -13 °F to +165 °F (– 25 °C to +74 °C).

Place all batteries on battery heater mats in the enclosure. The battery heater mats are designed to extend the life of the batteries.

An integral system shall prevent the battery from destructive discharge and overcharge. Batteries shall not be recharged when battery temperature exceeds 122 °F + 5 °F(50 °C ± 3 °C).

Furnish UPS battery according to the Department's TAP List.

D. Enclosure. Furnish an enclosure mountable to a standard Model 332, NEMA TS-2 traffic signal cabinet and be constructed of natural unpainted aluminum. Furnish cabinet size adequate to house "all" the UPS equipment including the controller unit, manual bypass switch and the (4) batteries. Key the enclosure to the State master #2 lock and include 2 keys.

Furnish a base seal for use between the enclosure to the concrete foundation or riser of continuous tape gasket material, minimum 1/8-inch (3 mm) thickness. Completely seal the interface to the adjacent controller cabinet with silicone caulk.

Furnish an enclosure with a vent, fan and thermostat as per TEES Chapter 7, Section 2-Housings.

E. Warranty. Provide a two (2) year factory-repair warranty for parts and labor on the UPS from date of acceptance by the State. Warrant batteries for full replacement for two (2) years from date of purchase.

Furnish materials according to the Department's TAP List.

740 PAVEMENT MARKING MATERIAL

740.01 General. Permanent pavement marking materials that meet the requirements of this specification and that have passed the service test required by Supplement 1047 are included on the Approved List maintained by the Office of Materials Management (OMM). OMM may retest pavement marking materials pre-qualified by a service test to determine formulation compliance to pre-qualified material and compliance with physical properties specified herein. Certified test data and samples will be furnished by the manufacturer to OMM. Failure of testing or certified test data to show formulation conforming to pre-qualified material or compliance with specified physical properties may be cause for removal of the material from the Approved List.

Ensure that the marking material is delivered in containers that are clearly marked to indicate the number of gallons (liters), weight or size of material, material density (weight per unit volume), material color, batch number or other similar manufacturer's identification, date of production, and the company name and address.

740.02 Traffic Paint. Furnish white and yellow ready-mixed traffic paint suitable for marking various types of pavement. Furnish paint that is a suitable binder for glass beads, 740.09 Type A, on pavement exposed to traffic. Furnish Type 1 paint that will not deteriorate in storage, within one year after date of receipt, to the extent that it cannot be readily broken up with a paddle to a smooth uniform paint capable of easy application by spray. Furnish Type 1A paint that will not deteriorate in storage in accordance with the manufacturer's recommendation.

Furnish paint that does not bleed or discolor when sprayed on asphalt concrete surfaces.

Type 1 paint is the fast dry, water-based, 100 percent acrylic type.

Type 1A paint is fast dry, water-based, 100 percent acrylic type, used for cold weather applications.

Ensure that Type 1 and Type 1A conforms to the following requirements:

Property	Test Method	Requirements (Applies to both White and Yellow, unless noted)
Total Solids	ASTM D2369	70% minimum by weight
		58% minimum by volume
Titanium Dioxide, rutile type II	ASTM D1394	1 lb/gal (120 g/l) minimum, White 0.2 lb/gal (24 g/l) minimum, Yellow
Pigment % by Weight	ASTM D3723	+/- 2% of qualifying sample
Weight per Gallon	ASTM D1475	+/- 0.3 lb/gal (36 g/L) of qualifying sample
Color	SS 1047	Appendix A
Viscosity (krebs units)	ASTM D562	70 minimum and 95 maximum @ 77 °F (25 °C)
Lab Drying Time	ASTM D711	10 minutes max. @ 77 °F (25 °C), 50% RH 12 minutes max. @ 50 °F (10 °C), 50% RH 14 minutes max. @ 35 °F (1.7 °C), 50% RH

Prequalify materials according to Supplement 1047. Use materials certified according to Supplement 1089. Furnish materials according to the Department's Approved List.

740.03 Polyester Pavement Marking. Ensure that the polyester pavement marking material supplied is a two part polyester system capable of being applied at ambient temperature down to 50 °F (10 °C). Ensure that the material is capable of retaining reflective glass beads, 740.09 Type B, after application.

Ensure that the catalytic component of the system is the commercially available type recommended by the manufacturer of the polyester.

Ensure that the ratio of the catalyst to resin is specified by the manufacturer.

Ensure that the polyester conforms to the following requirements:

		Minimum	Maximum
1.	Consistency, Krebs units ASTM D562, Procedure A	70	90
2.	Field Dry Time (No Track), minutes	--	45
	Furnish pavement marking material that will be in "no tracking condition" in 45 minutes. The "no tracking condition" will be determined by applying the markings and beads at the specification requirements to dry pavements at a low temperature of 50 °F (10 °C) and high temperature of 120 °F (49 °C). Run tests at the manufacturer's highest and lowest recommended application humidity. The marking materials will be applied at the manufacturer's recommended application temperature. The "no tracking" time will be determined by passing over the line with a passenger car at a speed of 25 to 35 mph (44 to 55 kmph) in a simulated passing maneuver. A line showing no visual deposition of the material to the pavement surface when viewed at a distance of 50 ft (15 m) will be considered as showing "no tracking" and conforming to this requirement for time to "no track".		
3.	Prime Pigment Content, percent by weight of paint		
	White ASTM D1394	13.9	--
	Yellow ASTM D126 or Department approved lab method	13.8	--
4.	Pigment Content, percent by weight of paint ASTM D2698		
	White	--	40
	Yellow	--	41
5.	Nonvolatile Vehicle Solids Content, percent by weight of paint FED STD 141C, Method 4053.1		
	White	31	--
	Yellow	29	--
6.	Fineness of Dispersion, ASTM D1210 micrometers	50	--
7.	Bleeding Ratio, Fed. Std. TT-P-115F, Section 4.3.2		
	White	0.93	--
	Yellow	0.92	--
8.	Color:		
	a. White, Daylight Directional Reflectance, ASTM E1347	85	--
	b. Yellow 1. Refer to Highway Yellow Color Tolerance Chart PR Color No. 1, June, 1965 U.S. Dept. of Transportation, FHWA: Yellow, Color Difference 595-33538, ASTM D 2244	50	--
	i. Measure E, L, a, b as Cielab, Source "C"		
	L	+0.75	+1.0
	a	+0.9	+1.7
	b	+4.4	+5.1
9.	Dry Opacity, ASTM D 2805 at 0.005 wet Fed Std 141 No 4121 Process B, Method A, white and yellow	0.97	--
10.	Condition in container, Fed Std 141 No 3011.2, hand stirring by spatula, minutes		5

Prequalify materials according to Supplement 1047. Use materials certified according to Supplement 1089. Furnish materials according to the Department's Approved List.

740.04 Thermoplastic Pavement Marking. Furnish thermoplastic pavement marking material formulated expressly for use as retroreflective pavement markings on asphalt concrete or Portland cement concrete pavement. Furnish material that includes a mixture of Alkyd resins-19% minimum by weight at least one of which is solid at room temperature, and contains premixed glass beads 740.09 Type C, 30% minimum by weight, with a 1.50 minimum index of refraction. Ensure that the ingredients are well mixed so that all parts are evenly dispersed throughout. Ensure that there are no foreign objects, skins, dirt, or such ingredients that would cause staining, discoloration, or bleeding. Furnish suitable materials for application in molten form by extrusion method. Ensure that the material is capable of retaining reflective glass beads, 740.09 Type C, after application.

A. Specific Gravity. Ensure that the thermoplastic compound has a specific gravity of 1.6 to 2.3 at 77 °F (25 °C) ASTM D 792.

B. Flowability. Meet percent residue requirements according to

1. AASHTO M 249, Section 4.3.6 and
2. AASHTO M 249, Section 4.3.8

C. Drying Time. AASHTO M249, section 4.3.2.

D. Field Placement Stability. After proper application and drying time, ensure that the material is not tacky and does not have an appreciable deformation or discoloration when subjected to typical vehicular traffic, and in air or road temperatures between -30 and 140 °F (-34 and 60 °C). Ensure that when the material is properly applied that it forms markings of a constant cross-section with a uniform density and character. Ensure that the markings maintain their original shape and pavement position.

E. Ring and ball Softening Point. Furnish a material that has a softening point of not less than 190 °F (88 °C) when tested according to ASTM E 28.

F. Impact Resistance. AASHTO M 249, section 4.3.4

G. Pigment Content. Furnish yellow material containing a minimum of 5 percent by weight of primary yellow lead free pigment (measured according to ASTM D 126 or Department approved lab method). Furnish white material containing a minimum of 10 percent Titanium Dioxide-Rutile Type -2 by weight of white pigment.

H. Color.

	Minimum	Maximum
a. White, Daylight Directional Reflectance, ASTM E 1347	75	--
b. Yellow 1. Refer to Highway Yellow Color Tolerance Chart PR Color No. 1, June, 1965 U.S. Dept. of Transportation, FHWA: Yellow, Color Difference 595-13538, ASTM D 2244	50	--
Measure E, L, a, b as Cielab, Source "C"		
L	+0.75	+1.0
a	+0.9	+1.7
b	+4.4	+5.1

I. Yellowness Index, AASHTO M 249, section 4.3.7

Prequalify materials according to Supplement 1047. Use materials certified according to Supplement 1089. Furnish materials according to the Department's Approved List.

740.05 Preformed Pavement Marking. Furnish the preformed material suitable for retroreflective pavement markings on asphalt concrete or portland cement concrete pavement. Furnish material that is free of cracks and that has edges that are straight, true, and unbroken. Ensure that the material is flexible, formable, and suitable for application with an adhesive without heating. Furnish material containing glass beads uniformly distributed throughout with a 1.50 minimum index of refraction. Ensure that the material has a uniform surface layer of firmly bonded glass beads to provide the initial minimum specific luminance values specified for the various types of material.

Furnish material that resists deterioration by contact with highway deicing chemicals or because of the oil content of asphalt concrete pavement, or from oil droppings and other effects of traffic.

A. Type A1 Material. Furnish Type A1 material conforming to ASTM D 4505, Level 1, Classes 2 or 3, and that have a thickness of not less than 0.090 inch (2.28 mm), including any pre-coated adhesive layer.

B. Type A2 Material. Furnish Type A2 material conforming to ASTM D 4505, Level 1, Classes 2 or 3, , and that have a thickness of not less than 0.060 inch (1.52 mm), including any pre-coated adhesive layer.

C. Type A3 Material. Furnish Type A3 material conforming to ASTM D 4505, Level 1, Classes 2 or 3, skid resistance level A, and that have a minimum thickness at the thinnest portion of the cross-section of not less than 0.020 inch (0.50 mm), including any pre-coated adhesive layer.

Prequalify materials according to Supplement 1047. Furnish materials according to the Department's Approved List.

740.06 Work Zone Pavement Marking. Furnish work zone pavement marking material conforming to ASTM D 4592, Type I (removable) or Type II (non-removable) with the following modifications:

A. Type I (removable): 0.030-inch (0.76 mm) minimum thickness.

B. Type II (non-removable): 0.015-inch (0.38 mm) minimum thickness.

Furnish materials according to the Department's Approved List.

740.07 Epoxy Pavement Marking Material. Ensure that the material supplied is a 100 percent solids two-part epoxy system capable of being applied at ambient temperature down to 50 °F (10 °C). Furnish a material capable of retaining reflective glass beads 740.09 type D, after application.

Furnish epoxy conforming to the following requirements:

A. Formulation. Furnish epoxy formulated as a Long Life Pavement Marking System, capable of providing a minimum of 4 years of performance. Ensure that the epoxy is designed to provide simple volumetric mixing ratio of its components (such as 2:1).

B. Epoxide Number. Ensure that the epoxide number of the epoxy resin is the manufacturer's target value ±0.05 as determined by ASTM D 1652 for both white and yellow Part A on a pigment free basis.

C. Amine Number. Ensure that the amine number of the curing agent (Part B) is the manufacturer's target value ±50 according to ASTM D 2074 on a pigment free basis.

D. Laboratory Drying Time. Ensure that the pavement marking material, when mixed in the proper ratio and applied at the properly prescribed wet film thickness at 75 ± 2 °F (24 ± 0.5 °C) and with the proper saturation of glass beads, exhibit a no tracking time conforming to Table 740.07-1 when tested according to ASTM D 711.

E. Field Time to No-Track. Furnish pavement marking material that will be in "no tracking condition" conforming to Table 740.07-1. The "no tracking condition" will be determined by applying the markings and beads at the specification requirements to dry pavements at a low temperature of 45 °F(7 °C) and high temperature of 120 °F (49 °C). Run tests at the manufacturer's highest and lowest recommended application humidity. The marking materials will be applied at the manufacturer's recommended application temperature. The "no tracking" time will be determined by passing over the line with a passenger car at a speed of 25 to 35 mph (44 to 55 kmph) in a simulated passing maneuver. A line showing no visual deposition of the material to the pavement surface when viewed at a distance of 50 ft (15 m) will be considered as showing "no tracking" and conforming to this requirement for time to "no track". Protect the line from tracking during the setting period by coning off or as shown on the plans.

F. Field Curing. Furnish epoxy pavement marking material capable of fully curing at a constant surface temperature of 45 °F (7 °C) or above.

G. Hardness. Furnish epoxy pavement marking materials, when tested according to ASTM D 2240, that have a Shore D Hardness of between 70 and 90. Allow

samples to cure at room temperature 75 ± 2 °F (24 ± 0.5 °C) for a minimum of 24 hours and a maximum of 72 hours before performing the indicated test.

H. Certified test data. Provide a material manufacturer's certified test data showing the material complies with the provisions of this specification. The provisions of a certification of compliance do not waive a state inspection, sampling, or testing.

I. Infrared Spectra. Supply a copy of the infrared spectra of each component on each lot number

J. Material Performance Qualifications. Ensure that the manufacturer has expertise and performance history including: completed and passed service tests according to Supplement 1047. ; verifiable installations; ample production capacity; proper facility; compliance with EPA regulations; verifiable quality control program; and has passed a minimum of 4 years of performance (durability and retroreflectivity) on concrete or asphalt surface in the State.

K. Condition in Container. Fed Std 141 No. 3011.2 Hand stirring by spatula. 5 minutes maximum.

TABLE 740.07-1

Description	Slow Dry Epoxy Requirement	Fast Dry Epoxy Requirement
Laboratory Dry Time ASTM D 711	≤ 45 minutes	≤ 10 minutes
Field Time to No-Track	Between 15 to 45 minutes	< 10 minutes

Prequalify materials according to Supplement 1047. Use materials certified according to Supplement 1089. Furnish materials according to the Department's Approved List.

740.08 Heat-Fused Preformed Plastic Pavement Marking Material. Furnish heat-fused preformed thermoplastic pavement marking materials conforming to the following:

Material Type	Thickness	Pre-heat	Post-heat
Type A90	90 mil (2.29 mm)	Yes	Yes
Type B90	90 mil (2.29 mm)	No	Yes
Type A125	125 mil (3.18 mm)	Yes	Yes
Type B125	125 mil (3.18 mm)	No	Yes

Furnish heat-fused preformed thermoplastic pavement marking materials conforming to AASHTO M249 with the following the following requirements:

A. Pigments. Furnish white material with sufficient titanium dioxide pigment to meet FHWA Docket No. FHWA-99-6190 Table 5 and Table 6 as revised and corrected. Furnish yellow material with sufficient pigment to meet FHWA Docket No. FHWA-99-6190 Table 5 and Table 6 as revised and corrected. The yellow pigments must be organic and must be heavy-metal free.

B. Heating indicators. Furnish the material with the top surface of the material (same side as the factory applied surface beads) shall have regularly spaced indents.

The closing of these indents during application, shall act as a visual cue that the material has reached a molten state allowing for satisfactory adhesion and proper bead embedment, and as a post-application visual cue that the application procedures have been followed.

C. Skid Resistance. Furnish the material with properly applied and embedded surface beads, must provide a minimum resistance value of 45 BPN when tested according to ASTM E 303.

D. Environmental Resistance. Furnish the material that must be resistant to deterioration due to exposure to sunlight, water, salt or adverse weather conditions and impervious to oil and gasoline.

Ensure that the material contains reflective glass beads, 740.09 Type E. Prequalify materials according to Supplement 1047. Furnish materials according to the Department's Approved List..

740.09 Glass Beads. Furnish certified test data for the arsenic and lead content of all glass bead samples sent to the Department for testing to ensure that all glass beads furnished to the Department contain no more than 200 parts per million of arsenic or lead as determined in accordance with Environmental Protection Agency testing methods 3052, 6010B, or 6010C, according to SEC 1504 STANDARDS. Section 109 of title 23, United States Code, (r) Pavement Markings.

A. Type A. Furnish Type A glass beads for traffic paint conforming to Supplement 1008 and to AASHTO M 247, Type 1 without flotation properties but dual coated (for moisture resistance and adhesion), with the following exception: 4.6 Flotation Test.

Ensure that the glass beads for traffic paint are packaged in bags designated "740.02".

Use materials certified according to Supplement 1089. Furnish materials according to the Department's Approved List.

B. Type B. Furnish Type B glass beads for polyester marking material conforming to Supplement 1008 and AASHTO M 247, Type 1 with 50 ± 5 percent flotation coating and ensure that a 50 ± 5 percent moisture resistant coating is retained on each sieve, with the following exception: 4.6 Flotation Test. Ensure that the minimum percent floating equals 90 of flotation coated beads or 40.5 percent of total mixture.

Ensure that the glass beads for polyester marking material are packaged in bags designated "POLY".

Use materials certified according to Supplement 1089. Furnish materials according to the Department's Approved List.

C. Type C. Furnish Type C glass beads for thermoplastic material conforming to Supplement 1008 and meeting the following specification.

Sieve Size	Percent Retained		
No. 16 (1.18 mm)	3 maximum	**Refractive Index**	1.50 to 1.60
No. 20 (850 µm)	5 to 20	**Roundness**	80 minimum
No. 40 (425 µm)	65 to 95	**Coating**	Moisture resistant (for drop-on beads only)
No. 50 (300 µm)	0 to 5		

Ensure the glass bead packaging is clearly marked "THERMO"

Use materials certified according to Supplement 1089. Furnish materials according to the Department's Approved List.

D. Type D. Furnish Type D glass beads for Epoxy Pavement Marking conforming to Supplement 1008.

Ensure that the glass bead packaging clearly indicates EPOXY - SIZE I or EPOXY SIZE II.

Ensure that the glass beads have the following gradation when tested according to Supplement 1008.

SIZE I		SIZE II	
Sieve Size	**Percent Retained**	**Sieve Size**	**Percent Retained**
No. 10 (2.00 mm)	0	No. 20 (850 µm)	0 to 5
No. 12 (1.70 mm)	0 to 5	No. 30 (600 µm)	5 to 20
No. 14 (1.40 mm)	5 to 20	No. 50 (300 µm)	30 to 75
No. 16 (1.18 mm)	40 to 80	No. 80 (180 µm)	9 to 32
No. 18 (1.00 mm)	10 to 40	No. 100 (150 µm)	0 to 5
No. 20 (850 µm)	0 to 5	Pan	0 to 2
Pan	0 to 2		

Reflective Media: Ensure that the glass beads are smooth, clear, free from any air inclusions, and scratches that might affect their functions as a retro-reflective media, and that have the characteristics listed below.

Roundness (Percent by Weight): Ensure that not more than 20 percent of the glass beads are irregular or fused spheroids and that at least 80 percent of the beads are true beads.

Index of Refraction: Ensure that the refractive index of the beads is a minimum of 1.50 as determined by the liquid immersion method at 77 °F (25 °C). Ensure that the silica content of glass beads is not less than 60 percent.

Coating: Furnish Size I glass beads that are coated with a silane-type adherence coating to enhance its embedment in, and adherence to the applied binder film. Ensure that the coated beads emit a yellow-green fluorescence when tested by the Dansyl Chloride test procedure. Furnish Size II glass beads that are treated with a moisture-proof coating. Ensure that both types of glass beads show no tendency to absorb moisture in storage and remain free of clusters and lumps. Ensure that

they flow freely from the dispensing equipment at any time when surface and atmosphere conditions are satisfactory for marking operations.

Determine the moisture-resistance of the glass beads based on AASHTO T 346 section 9.

Use materials certified according to Supplement 1089. Furnish materials according to the Department's Approved List.

E. Type E. Furnish heat-fused preformed plastic pavement marking materials that contain a minimum of thirty percent (30%) intermixed graded glass beads by weight and factory applied coated surface beads in addition to the intermixed beads at a rate of 1 lb. (± 10%) per 10 sq. ft.

Furnish factory applied coated surface beads with the following specifications:

1) Minimum 80% rounds

2) Minimum refractive index of 1.50

Furnish intermixed graded glass beads and factory applied coated surface beads that conform to Type 1 and/or Type 3 AASHTO M247 as recommended by the manufacturer.

Use materials certified according to Supplement 1089. Furnish materials according to the Department's Approved List.

740.10 Spray Thermoplastic Pavement Marking.

Furnish spray thermoplastic pavement marking material specially formulated to be used as retroreflective pavement markings on asphalt concrete or Portland cement concrete pavement. Furnish material that includes a mixture of resins, at least one of which is solid at room temperature, and contains uncoated premixed glass beads, 740.09 Type C. Ensure that the ingredients are well mixed so that all parts are evenly dispersed throughout. Ensure that there are no foreign objects, skins, dirt, or such ingredients that would cause staining, discoloration, or bleeding. Furnish suitable materials for spray application in molten form. Ensure that the material is capable of retaining drop on reflective glass beads, 740.09 Type C, after application.

A. Composition.

	White	Yellow
Binder	25% Min.	25% Min.
TiO2 Pigment (Type II Rutile)	10% Min.	
Lead-Free Pigment (Yellow 83)	N/A	*
Inter mixed Glass Beads	30% Min. (by weight)	30% Min. (by weight)
Filler	35% Max.	42% Max.

*amount of lead-free pigment is at the discretion of the manufacturer, as long as all other compositional requirements are met

B. Binder. Furnish alkyd-based binder consisting of a mixture of synthetic resins, at least one of which is solid at room temperature, and high boiling plasticizers. Ensure at least one third of the binder composition is maleic modified glycerol ester of rosin and is no less than 8 percent by weight of the entire material formulation.

C. Pigment. Furnish titanium dioxide pigment that is a Rutile type with a minimum purity of 92%.

Use lead-free Pigment Yellow 83 produced to meet the requirements of AMS-STD-595A Color No. 13538.

D. Filler. Ensure filler to be incorporated with the resins is a white calcium carbonate, silica, or any approved substitute. Ensure that any filler, which is insoluble in 6N hydrochloric acid, passes a 150 µm (No. 100) sieve.

E. Color. Furnish white spray thermoplastic that is pure white and free from any tint and has a minimum daylight reflectance (Y) of 75. When tested according to ASTM D4960 and E313 the yellowness index is not to exceed 0.15.

Visually match yellow spray thermoplastic with AMS-STD-595A No. 13538. Ensure daytime reflectance (Y) is greater than 45.

Ensure white and yellow colors fall within the chromaticity coordinates of the color box in Appendix A of Supplement Specification 1047.

G. Specific Gravity. Furnish spray thermoplastic material that has a specific gravity of 1.85-2.15.

H. Softening Point. After heating the marking compound for 4 hours ± 5 min. at 375ºF ± 3ºF (190ºC ± 2ºC) and testing in accordance with ASTM E28, ensure material has a minimum softening point of 180ºF (82°C) as measured by the ring and ball method.

I. Bond Strength. After heating the marking compound for 4 hours ± 5 min. at 375ºF ± 3ºF (190ºC ± 2ºC) ensure tensile bond strength exceeds 180 psi (1.24 MPa) when tested in accordance with ASTM D4796.

J. Impact Resistance. After heating the marking compound for 4 hours ± 5 min. at 375ºF ± 3ºF (190ºC ± 2ºC) ensure impact resistance is a minimum of 50 inch pounds (0.576 kilogram meters) when tested in accordance with ASTM D2794. Ensure no cracks or bond loss occurs when a 0.0625 inch (1.587 mm) thick film drawdown is made at 375ºF ± 3ºF (190ºC ± 2ºC) on an unprimed sandblasted Portland cement concrete block. Test sample with a male indenter 5/8 inch (15.875 mm) and no female Die, at room temperature.

K. Indentation Resistance. When tested according to ASTM D 2240 using a Shore Durometer, Type A2, with a 2.2 pound (1 kg) load, ensure hardness is between 5 and 30 after 15 seconds of contact with the sample. Ensure durometer and sample is at 113ºF ± 3ºF (45ºC ± 2ºC).

Prequalify materials according to Supplement 1047. Use materials that follow the requirements of Supplement 1089.

748 WATER MAIN AND SERVICE BRANCH MATERIAL

748.00 Acceptance. Follow the requirements listed in each 748 section.

748.01 Ductile Iron Pipe, Joints, and Fittings. Furnish ductile iron pipe conforming to ANSI/AWWA C151/A21.51 and to ANSI/AWWA C150/A21.50 for thickness design. Furnish pipe with a cement mortar lining conforming to ANSI/AWWA C104/A21.4. Furnish gaskets conforming to ANSI/AWWA for each length of pipe and suitable for the type of joint of the pipe. Ship gaskets in a separate container.

Furnish push-on joints, mechanical joints, and boltless restrained joints conforming to ANSI/AWWA C111/A21.11. For restrained joints, ensure that the restraint is a design approved by the owner of the utility and provides a positive lock designed to prevent joint separation. Steel locking segments molded into a gasket to grip the pipe do not meet the requirements for this joint.

Ball and socket joints are suited for underwater installations. The Contractor may use ball and socket joints for other types of installations where an appreciable amount of joint deflection and a positive lock against joint separation are required.

Manufacture fittings for ductile iron pipe according to ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53, and ANSI/AWWA C111/A21.11. For fittings 16 inches (406 mm) or larger, use ductile iron only. Ensure that fittings are cement mortar lined according to ANSI/AWWA C104/A21.4.

Furnish materials according to the Department's QPL.

748.02 Polyvinyl Chloride (PVC) Pipe, Joints, and Fittings. Furnish PVC pipe conforming to AWWA C 900, AWWA C 905, AWWA C909, or ASTM D 2241. Furnish push-on type pipe joints conforming to ASTM D 3139 with a thickened bell and with a rubber gasket conforming to ASTM F 477.

Use PVC, PE, or PB pipe and couplings, and solvent cements made from compounds that are tested and certified as suitable for potable water distribution products by the National Sanitation Foundation (NSF) Testing Laboratory or the Canadian Standards Association Testing Laboratory, or any other similarly accredited testing agency acceptable to the Laboratory. Do not use PVC, PE, or PB pipe and couplings, or solvent cements containing any ingredient in an amount that has been demonstrated to migrate into water in quantities considered to be toxic, as tested according to Sections 3 and 4 of NSF Standard Number 14.

Furnish materials according to the Department's QPL.

748.03 Polyethylene (PE) Service Branches and Fittings. Furnish PE service branches and fittings conforming to AWWA C901.Furnish material with plain ends conforming to the potable waterline requirements specified in 748.02.

Furnish materials according to the Department's QPL.

748.04 Glass-Fiber-Reinforced Polymer Mortar Pipe (RPMP), Joints, and Fittings. Furnish RPMP conforming to ASTM D 3517 or AWWA C 950. Design of underground and above ground glass-fiber-reinforced polymer mortar pipe and fittings shall meet design requirements of AWWA M 45: Fiberglass Pipe Design Manual.

Furnish double-bell push-on type fiberglass joints conforming to ASTM D 4161 and with a rubber gasket conforming to ASTM F 477. Furnish restrained joints and fittings conforming to ASTM D 3517 or AWWA C 950.

Provide a minimum pipe stiffness of 18 psi.

Furnish certified test data as defined in 101.03 to the Engineer.

748.05 Copper Service Branches and Fittings. Furnish copper service branches conforming to ASTM B 88 (ASTM B 88M), Type K. Assemble branches using flare-type compression fittings conforming to AWWA C800. Ensure a minimum working pressure for the branches of 150 pounds per square inch (1.0 MPa). Use either coil type (temper 060 annealed) or drawn type (temper H) material.

Furnish high-quality copper brass fittings with AWWA C800 dimensions.

Furnish materials according to the Department's QPL.

748.06 Steel Pipe Encasement. Furnish steel casing pipe conforming to ASTM A 139/A 139M, Grade B or ASTM A 53, Grade B, that is galvanized on exterior and interior surfaces as specified in Section 711.02. Furnish the manufacturer's certification. Steel casing pipe shall have a minimum wall thickness as shown below:

Pipe Diameter		Wall Thickness	Wall Thickness	
(in)	(mm)	Designation	(in)	(mm)
4 to 10	100 to 260	Standard	0.237 to 0.365	6.02 to 9.27
12 to 22	300 to 560	Standard	0.375	9.53
24 and larger	600 and larger	Extra-strong	0.500	12.7

For steel casing pipe specified to be bored or jacked, provide ungalvanized pipe with 0.500-inch minimum wall thickness.

748.07 Polyethylene Encasement. Furnish 8-mil (200 μm) thick polyethylene encasement material conforming to ANSI/AWWA C105/A21.5.

748.08 Gate Valve and Valve Box. Furnish ductile iron gate valves conforming to AWWA C509 resilient seated.

Gate valves shall open counter-clockwise. Use valves suitable for push-on and mechanical joints for ductile iron pipe and for push-on joints for PVC pipe.

Furnish cast iron valve boxes consisting of adjustable two or three-piece with cover and with a base corresponding to the size of the valve. Use heavy-duty type valve boxes for locations within existing or proposed pavement, driveway, or other traveled areas. Ensure that valve boxes are coated with an asphaltic coating by the manufacturer. The cover shall have the word "WATER" cast in it.

Furnish materials according to the Department's QPL.

748.09 Inserting Valve and Valve Box. Furnish inserting valves that operated like ordinary gate valves, with the same gate and seating assembly as AWWA C509 gate valves. Furnish material that consist of a two-piece sleeve for assembly around the main the valve, and a valve box conforming to 748.08. Furnish the equipment

necessary to drill the main wall and insert the valve according to the manufacturer's recommendations.

Furnish materials according to the Department's QPL.

748.10 Cutting-in Sleeve, Valve, and Valve Box. Furnish cutting-in valves with the same gate and seating assembly as AWWA C509 gate valves. Furnish material that consists of a cutting-in sleeve and valve suitable for assembling over the ends of a cutout length of existing pipe, according to the manufacturer's recommendations, and a valve box conforming to 748.08. Furnish sleeves and valve joints of the mechanical joint type.

Furnish materials according to the Department's QPL.

748.11 Tapping Sleeve, Valve, and Valve Box. Furnish tapping valves with the same gate and seating assembly as AWWA C509 gate valves. Furnish material that consists of a two-piece sleeve for assembly around the main, the valve, and a valve box conforming to 748.08. Furnish cast iron, epoxy-coated steel, or stainless steel tapping sleeves. Furnish the equipment necessary to drill the main wall through the valve according to the manufacturer's recommendations.

Furnish materials according to the Department's QPL

748.12 Tapping Saddle and Corporation Stop. Furnish iron, bronze, brass, or, AWWA C223, stainless steel tapping saddles. Furnish band type or double-strap type tapping saddles, with International Pipe Standard (IPS) tapping or AWWA tapered thread inlet.

For use with saddles, provide bronze alloy corporation stops with IPS inlet thread of AWWA tapered thread and with outlet thread compatible with connecting pipe, without special adapters. For direct tapping, provide bronze alloy corporation stops with AWWA tapered inlet thread and with outlet thread compatible with connecting pipe, without special adapters.

Furnish materials according to the Department's QPL.

748.13 Service Stop and Service Box. Furnish bronze service stops with coupling threads conforming to AWWA C800. Use service stops designed so that water pressure from the inlet side of the body provides additional sealing action. Furnish service stops that open counter-clockwise.

Use Buffalo type service boxes. Furnish covers that have the word "WATER" cast in raised letters. Securely fasten covers with a bronze or brass bolt.

Furnish materials according to the Department's QPL.

748.14 Meter, Setting, Stop, and Chamber. Furnish meter setting yokes that allow the meter to be readily installed without disturbing piping. Furnish angle pattern meter stops with lock wings for the street side of the meter piping. Furnish check valves for the customer side of the meter piping. Furnish chambers composed of concrete, vitrified clay, PVC, or PE. Furnish double walled, tightly fitting lids.

748.15 Fire Hydrant. Furnish cast iron, dry-barrel post type fire hydrants conforming to AWWA C502, with the following modifications:

Furnish hydrants incorporating an approved groundline breakable flange and valve stem coupling.

Furnish compression type hydrants with the valve opening against the pressure. Ensure that the valve end of the valve stem is designed to eliminate contact of dissimilar metals. Ensure that the valve stem is at least 1-inch (25 mm) diameter or 1-inch (25 mm) square steel between the hydrant operating nut and the valve, except for the valve stem coupling located at the point corresponding to the breakable flange.

Furnish a main valve port that is at least 4 1/4-inch (108 mm) diameter. Furnish a rubber faced valve.

Ensure that the hydrant is designed so the nozzles may be oriented to point in any direction. Ensure that the hydrant connection to the pipe has at least a 6 inches (150 mm) inside diameter. Furnish push-on or mechanical type joints conforming to ANSI/AWWA C111/A21.11.

Ensure that the hydrant has one center-front pumper nozzle of 4-inch (100 mm) internal diameter with male threads to match the fire apparatus of the maintaining agency. Furnish two hose or streamer nozzles of 2 1/2-inch (63 mm) internal diameter with male threads to match apparatus of the maintaining agency. Ensure that nozzle sections are designed to lock into the hydrant body using locking lugs or threads. Furnish nozzles with threaded cast iron caps having an integral nut of the same design as the hydrant operating nut.

Contact the maintaining agency to determine the desired color and number of coats of enamel for the hydrants.

Furnish materials according to the Department's QPL.

Special Thanks to the 2023 Construction Administration Team:

Gary Angles, Clint Bishop, Dave Flood, Merka Flynn, Hans Gucker, Bob Jessberger, Julia Miller, Steve Slomski, Rebecca Wagner, as well as the multitude of support staff, and offices that helped create this document!

SUBJECT INDEX

APPENDIX C-2

ODOT CMS SUPPLEMENTAL ITEM S-1015

S-1015 Compaction Testing for Unbound Materials

General

Supplement 1015 details the compaction testing requirements for all ODOT projects. ODOT technicians and testing personnel provided by the Contractor must follow the testing procedures described in S-1015.

When the Contractor will provide the compaction testing, one of two possible supplemental specifications will be included in the contract documents. The two supplemental specifications, *SS-878* and *SS-879*, are similar, but *SS-878* pays for the inspection and testing as a lump sum pay item, while *SS-879* pays for the work by providing incentive pay to the contractor.

There is one compaction and inspection table for S-1015, *SS-878* and *SS-879*. Table 1015.10-1 in Section *1015.10* includes columns for the materials, test or method, maximum lot size and minimum number of test. The same number and type of inspections and compaction tests are taken regardless of which specification is used in the contract.

SS-878 Inspection and Compaction Testing of Unbound Materials

This note is used when construction personnel are limited and the District wants full time inspection and compaction testing for the work.

SS-878 pays for the inspection and compaction testing as a lump sum pay item and covers Items *203*, *204*, *205*, *206*, *304*, 307, *411*, *503*, *603* and *MSE* wall select granular backfill.

The major aspects of the specification are as follows:

1. The Contractor is to supply full time qualified inspection and compaction testing for all specified items.
2. The compaction tests are performed according to S-1015.
3. The documentation is performed on Department forms.
4. The documentation is presented to the Engineer daily and a summary report is required every two weeks.
5. There are qualifications requirements for the inspection and compaction personnel.
6. The Department will perform QA compaction tests.
7. There is a lump sum payment for this work.
8. Several Districts are using their own notes that require the Contractor to supply the compaction testing for a project. This supplemental specification requires comprehensive inspection and compaction testing for the work.

SS-879 QC/QA for Embankment Construction

The major aspects of the specification are as detailed below:

1. Several of the sections in this specification refer to *SS-878* because they are basically the same work with the payment mechanism being different.
2. The Contractor supplies full time qualified inspection and compaction testing for Items *203* and *204*.
3. The compaction tests are performed according to S-1015.

4. The documentation is performed on Department forms.
5. There are qualifications requirements for the inspection and compaction personnel.
6. The Department will perform QA compaction tests.

This supplemental specification is very similar to *SS-878*, except there is a pay adjustment plus or minus 4 percent to the amount bid for Items *203* and *204*. This specification allows for more Contractor responsibility for the work with an appropriate incentive. It also allows the Department to reduce the amount of full time inspection of the work.

Metrication and Rounding

Most of the tables, forms, graphs, curves and tests in this section are in English and Metric units. The units are labeled with the English units first and the Metric units are in parenthesis, i.e., English (metric). All forms ending with an M are metric. (For example, *CA-EW-5* is the English compaction form and CA-EW-5-M is the Metric form).

Weight measurements should be measured to the nearest 0.01 of a pound or kilogram. All calculations are normally recorded to the nearest 0.1 or 4 significant digits. Normally the final compaction results are recorded to the nearest percentage of compaction and acceptance is based on rounding. The rounding of 97.6 percent compaction is rounded up to 98 percent compaction, while 97.5 is rounded down to 97 percent compaction. The rounding of other calculations and measurements are done in a similar manner.

Importance of Proper Inspection and Compaction Testing

The Contractor constructs the embankment. As the representatives of the Department, our Inspectors and Engineers observe the work to ensure compliance with the specifications. As the Department inspects the work, we give instructions to the Contractor, such as the material is too dry, too wet, not enough stability or density.

What happens when an embankment fails and we determine that one of the following has occurred?

1. The instructions to the Contractor were in error.
2. Compaction tests were performed incorrectly.
3. Compaction forms were incomplete.
4. No inspection or part-time inspection occurred during the construction.

All of the above reasons are arguments that are issues during a claim. Valid or not, these are reasons that will be debated when responsibility is discussed. Considerable financial loss to the Department could result during these negotiations or in court because of any one of the above reasons.

Our goal with this section is to minimize the Department liability in the above claim situations.

In addition, compaction testing is an important evaluation tool that measures the quality of the earthwork construction work. Therefore, this entire section is dedicated to obtaining correct and accurate results.

Compaction of Soils (1015.01)

Moisture-Density Relationship (1015.01.A)

In order to understand compaction testing, the project personnel must first understand the moisture-density relationship and some of the variables associated with this relationship.

A relationship exists between the density of a soil and the moisture content of a soil as the moisture content is varied while the compactive effort remains constant. A standard force is used in the test that closely approximates the densities that can be readily obtained in the field with sheepsfoot rollers and other types of common compaction equipment. The greatest density obtained in the test is termed “maximum density” and the corresponding moisture content is termed “optimum moisture.” This moisture-density relationship is shown in Figure 1015.01.A.

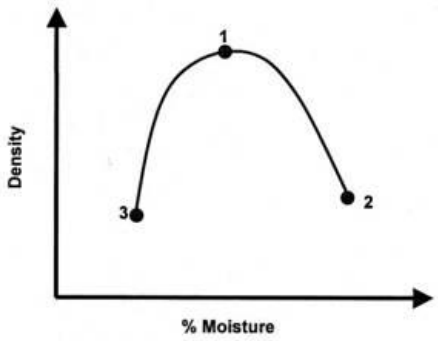


Figure 1015.01.A - Typical Moisture-Density Curve

The test used by the Department to determine the moisture-density relations of soil is AASHTO T-99, Method C. The basic principle involved in the moisture-density relationship is an important tool when evaluating a soil.

For a given force of compaction and given moisture content, a soil will have a corresponding density. Additionally, there is a particular moisture content for each soil at which a given compaction requirement can be obtained with less compaction effort than at any other moisture content. This moisture content is the optimum moisture content.

Structural properties of a soil vary with moisture content and density. For example, a clay soil at a low density will have very high load-supporting strength when dry, but when it is saturated at this same density it will have a very low load-supporting strength. Hence, when the structural properties of the soil are being determined, its moisture content and density must be defined and controlled to permit accurate evaluation of the soil in that particular condition.

Refer to Figure 1015.01.A to understand the influence of moisture on the compaction of soils. At point 3, the soil is compacted at a moisture content where the compactive effort cannot overcome the friction or resistance of the soil to achieve a maximum density. As the water content increases, the particles develop larger and larger water films around them, which tend to "lubricate" the particles and makes them easier to move about and reorient into a denser configuration.

However, as the moisture content is increased, we eventually reach point 1, where the density does not increase any further with water content. At point 1, the soil has just enough moisture to overcome most of the friction and not too much to have excess pore pressure to displace the soil.

As the moisture is increased from point 1 to 2, the density decreases as the water starts to displace and replace soil particles because of the excess pore pressure.

Making a Moisture-Density Curve (1015.01.B)

This section outlines procedures to determine the optimum moisture, maximum wet weight, and maximum dry weight of a soil, shale or granular materials. This data is used to determine the suitability of soil for use in embankment and subgrade and to establish a standard for field compaction control if needed.

The procedures outlined in this section follow AASHTO T-99, Method C with some minor modifications.

Equipment (1015.01.B.1)

The equipment needed to make a moisture-density curve is as follows:

1. Proctor Mold
    a. Cylindrical brass or cadmium-plated steel mold approximately 4 inches (102 mm) in diameter, 4.5 inches (114 mm) in height and having a capacity of 1/30 ft^3 (9.43 × 10-4 m^3).
    b. The cylinder is mounted on a removable base plate and fitted with a detachable collar approximately 2.5 inches (63 mm) in height.
2. Proctor Hammer
    a. Brass or cadmium-plated steel sleeve rammer having:
        i. A striking face 2 inches (50 mm) in diameter.
        ii. Weighing 5.5 lbs (2.5 kg).
        iii. Equipped to control the height of drop to 12 inches (305 mm).

3. Steel straightedge 12 inches (305 mm) long.
4. Scale of 25 lb (12 kg) capacity sensitive to 0.01 lbs (1 gram).
5. A 3/4-inch (19 mm) sieve.
6. Oil or gas stove or portable oven unless dried by other methods.
7. Baking pans, approximately 12 × 8.5 × 2.5 inches (300 × 200 × 63 mm).
8. Masonry trowel and putty knife.
9. If the test is performed in the field, use a large concrete block or piece of concrete beam.
    a. Minimum size is a 12 × 6 inch (300 × 150 mm) cinder block.
    b. Or a 4 × 12 inch (100 × 305 mm) solid concrete block.
    c. Do not use wood or asphalt.

Procedure (1015.01.B.2)

Use the form in Figure 1015.01.B to record test data as obtained by the procedure outlined in this section. This form shows an example of recorded test data. Each column is lettered and used throughout this section to facilitate referring to the explanation.

1. Secure a representative sample of soil of about 40 lbs (20 kg).
2. Pass the sample through a 3/4-inch (19 mm) sieve.
3. Wet or dry the sample.
    a. Change the moisture content to 4 to 6 percent below optimum.
    b. See 1015.01.F, “Estimating Optimum Moisture” in this section for more information.
4. Make a proctor.
    a. Make a specimen by compacting the prepared soil in the proctor mold.
        i. Make three equal layers to give a total compacted depth of about 5 inches (130 mm).
    b. Compact each layer by applying 25 uniformly distributed drops from the 5.5 lb (2.5 kg) rammer dropping from a height of 12 inches (305 mm) above the elevation of the soil.
    c. See Figure 1015.01.D for recommended Loose and Compacted Soil Lifts.
        i. Loose Lifts will change depending on the consistency of the soil.
    d. Ensure that the cylinder is resting on a uniformly rigid foundation during the compaction.
        i. Use a large concrete block or piece of concrete beam.
        ii. The minimum size is a 12 × 6 inch (300 × 150 mm) cinder block.
        iii. Or a 4 × 12 inch (100 × 305 mm) solid concrete block.
        iv. Do not use wood or asphalt.
5. Remove the extension collar.
    a. The soil should be less than ½ inch (13 mm) above the mold.
    b. If the soil is lower than the top of the mold, repeat the test.
    c. Carefully trim the compacted soil even with the top of the mold using the straightedge.
    d. Add fine material to fill any voids if necessary.
        i. Use the fines from the tested soil.
6. Weigh the cylinder and sample. Input this information in Column ‘A’
    a. Calculate the density of the specimen by subtracting the weight of the mold from the weight of the specimen and mold, and multiply the difference by 30 for English units and 1060 for metric units.
        i. Column A – 9.81 lbs = Column B
        13.34 - 9.81 = 3.53
        9.81 is the weight of the mold
        ii. Column B × 30 = Column C
        3.53 × 30 = 105.9
        iii. Column C is the wet density of the proctor soil.
7. Remove the material from the mold and slice vertically through the center.
    a. Take a representative sample of the material from one of the cut faces and determine the moisture content by a method outlined in section 1015.02.H “Alternate Tests for Moisture”.
    b. If the only available scales are those included in the compaction control kit, a 1 lb (0.5 kg) sample is required for the moisture determination. However, if a more sensitive scale is available use a 0.22 lb (100 gram) sample. The smaller sample will dry faster.
        i. The scales need to be leveled with a carpenter’s level. Put the scale on a piece of flat plywood then level the board. You may elect to level the weighting plate.
        ii. The older scales must also be balanced once it is leveled. The weighting mechanism should float between the top and bottom bar. If it does not then sand or pebbles can be added to the lever arm to make it balance.
    c. Calculate the dry weight and the moisture content as follows:

i. Column D…Weight of the dish and the wet soil.
96.2
ii. Column E…. Weight of the dish and soil after drying.
93.4
iii. Column F…Column D - E = Weight of Water
96.2 - 93.4 = 2.8
iv. Column H…Column E - G= Dry Soil Weight
93.4 – 40.0 = 53.4
v. Column I…F/H × 100 = Percent Moisture
Water Content = Weight of Water /Dry Weight
(2.8/53.4) × 100 = 5.2%
vi. Column J…C/(1+ I) = Dry Weight of the Soil
Dry Weight =Wet Weight/ (1 + Wc)
In the Example:
WD= 105.9/(1+0.052) = 100.5

8. Thoroughly break up the remainder of the material until inspection shows that it will pass a ¾ inch (19 mm) sieve. It is not necessary to pass all of the material through the sieve.
9. Add water in sufficient amount to increase the moisture content of the soil sample by 2 or 3 percent, and repeat the procedure outlined in D through H.
10. Repeat D through H, each time adding water until you obtain at least 4 readings for the wet weight, dry weight and moisture content.
    a. Continue the process until a minimum of two points are plotted on the wet and dry side of the dry weight curve and there is a decrease in the wet weight.
11. Use Figure 1015.01.C (1015.01.C-M) as an example and plot test data as follows:
    a. Plot wet weight, ‘Column C’ versus moisture content, ‘Column I’ of the successive tests on linear graph paper.
        i. Draw a smooth curve between the successive points.
        ii. The peak of this curve is the maximum wet weight of the material being tested.
        iii. This maximum weight is not used for compaction acceptance.
    b. Plot dry weight, ‘Column J’, versus moisture content, ‘Column I’, of the successive tests on linear graph paper.
        i. Draw a smooth curve between the successive points.
        ii. The peak of this curve is the maximum dry weight of the soil.
        iii. The moisture content at this point is the optimum moisture.
        iv. This curve can be used for compaction acceptance.

Figure 1015.01.C (1015.01.C-M) shows curves plotted from the test data in Figure 1015.01.B.

CA-EW-4
03/03/03

STATE OF OHIO
DEPARTMENT OF TRANSPORTATION
WORKSHEET FOR
MOISTURE-DENSITY TEST

Project No. 722 (68) Date: 3-30-99

County: Ashland Tare: 9.81(Mold Weight) Operator: Dave Johnson

Sample: 1

A Weight of Compacted Sample + Container lbs. (kg.)	B Weight of Sample lbs. (kg.)	C Weight of Sample lbs/ft³ (kg/m³)	Penetration and Resistance: Size in² (mm²)	Reading lbs. (N)	Pressure lbs/in² (mPa)	Moisture Determination: Dish No.	D Wet Wt. + Dish grams	E Dry Wt. + Dish grams	F Water Wt. grams	G Dish Wt. grams	H Soil Wt. grams	I % Water (Dry)	J Dry Weight of Soil lbs/ft³ (kg/m³)
13.34 (6.05)	3.53 (1.60)	105.9 (1696)				1	96.2	93.4	2.8	40.0	53.4	5.2	100.5 (1614)
13.63 (6.18)	3.83 (1.73)	114.6 (1837)				2	98.6	93.7	4.9	38.0	55.7	8.8	105.2 (1688)
13.87 (6.28)	4.06 (1.84)	121.8 (1953)				3	97.1	90.9	6.2	39.0	51.9	11.9	108.8 (1745)
14.15 (6.41)	4.32 (1.96)	129.6 (2078)	1/20 (12.3)	60 (267)	1200 (8.27)	4	99.6	91.7	7.9	41.0	50.7	15.6	112.1 (1798)
14.10 (6.42)	4.35 (1.97)	130.5 (2092)	1/10 (104.5)	40 (178)	400 (2.76)	5	94.8	86.2	8.6	40.0	46.2	18.6	110.1 (1764)
14.04 (6.37)	4.23 (1.92)	126.9 (2035)	1/3 (295)	50 (222)	150 (1.03)	6	95.2	84.5	10.7	38.0	46.5	23.0	103.2 (1654)

Max. Dry Weight: 112.5 (1802) lbs./ft³ (kg/m³)
Optimum Moisture: 15.5 %

Remarks:

Curve: Project Curve
DOT - 1038

Figure 1015.01.B – Moisture-Density Calculation Form

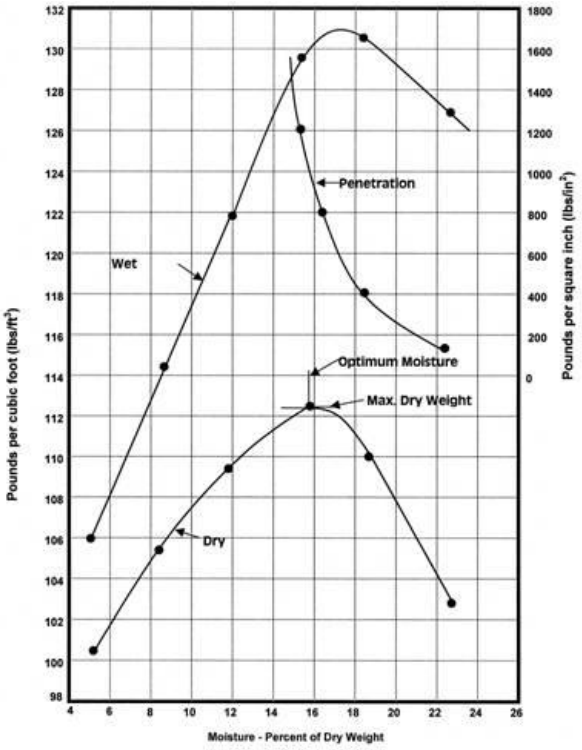


Figure 1015.01.C – Moisture-Density Curve Plot

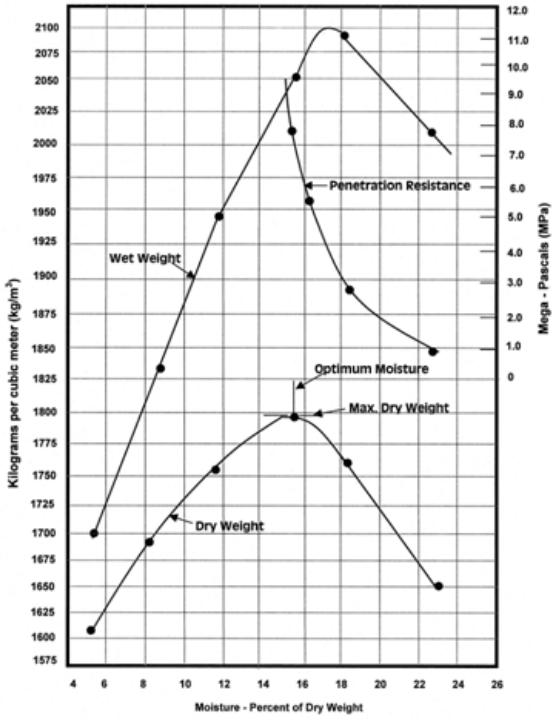


Figure 1015.01.C-M – Moisture-Density Curve Plot (metric)

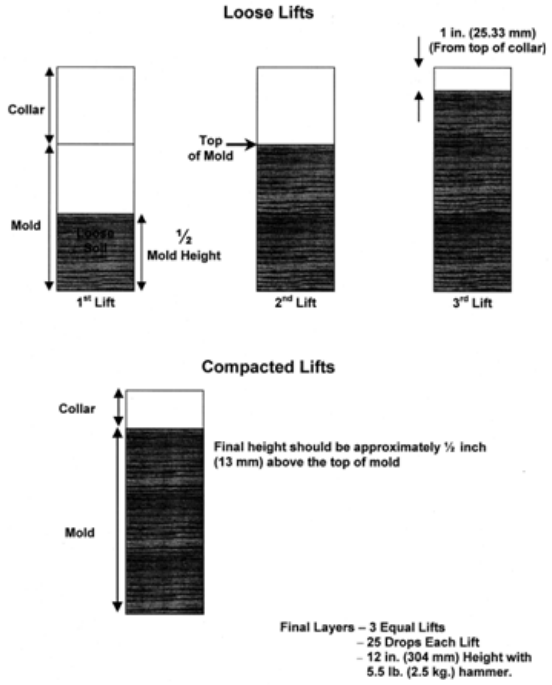


Figure 1015.01.D - Loose and Compacted Lifts for the Proctor Test

Ohio Typical Density Curves (1015.01.C)

The Ohio Typical Density Curves are a set of soil curves originally developed in the 1930's and 1940's to represent all the soils in Ohio. They were developed in the laboratory using the standard proctor test. They started with an original set of nine curves that represented over 1,000 samples. Additional curves were added that represent over 10,000 lab samples. These curves are plotted in Figure 1015.01.E. These curves are still used today to represent all the soils in Ohio. Using these curves minimizes the need to make moisture-density curves for each type of soil encountered in the field.

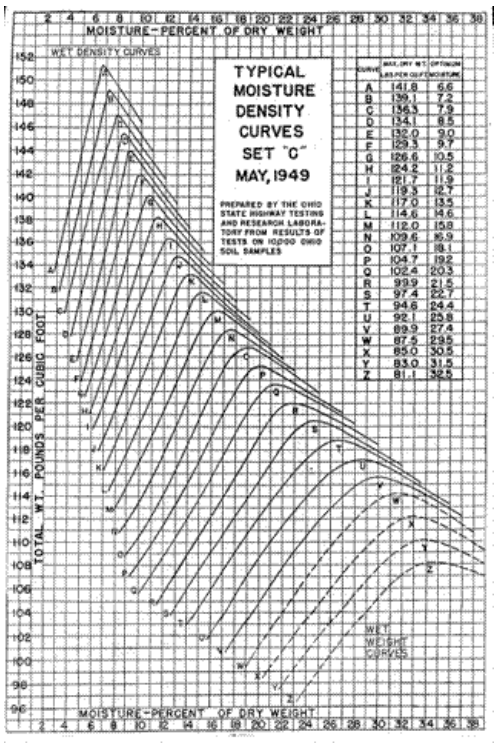


Figure 1015.01.E - Ohio Typical Density Curves

A one-point proctor test is used to choose the curve that represents the soil under consideration. The procedure is similar to the AASHTO T 272 test and is detailed in Supplement 1015.02.A in section 1015.02.F of this manual.

Usefulness of the Moisture-Density & the Ohio Typical Density Curves (1015.01.D)

By examining the moisture-density or the Ohio typical density curves, one can gain general information on the load-carrying capacity and other information about the soil properties.

The optimum moisture and maximum density of the moisture-density relationship are comparative factors. A high maximum density ranges from 125 to 140 lbs/ft^3 (2000 to 2250 kg/m^3) dry weight. A low maximum density ranges from 100 to 85 lbs/ft^3 (1600 to 1350 kg/m^3) dry weight. A low optimum moisture coincides with a high maximum density and will be on the order of 7 percent. A high optimum moisture coincides with a low maximum density and may be on the order of 25 percent.

The maximum density of a soil gives approximate information on its gradation and soil type. The approximate range of the maximum dry density for particular soils are as follows:

Soil Type	Typical Maximum Dry Density Pounds per Cubic Feet (Kilograms per Cubic Meter)
A-1 & A-2	120 to 135 (1922 to 2163) Granular Soils
A-2	120 to 130 (1922 to 2082) Granular Soils
A-3	110-to 120 (1762 to 1922) Granular Soils
A-4	105 to 120 (1682 to 1922) Silty Soils
A-6 & A-7	90 to 110 (1442 to 1762) Clayey Soils

The optimum moisture gives approximate information on the clay and silt content of the soil. The shape of the moisture-density curve varies from a sharply peaked parabolic curve to a flat one or to one sloping irregularly downward as the moisture content increases. This shape gives additional valuable information showing the influence of moisture on the load-supporting value of the soil. For example, a flat moisture-density curve indicates a soil that will have about the same load-supporting strength over a wide range in moisture contents, while a moisture-density curve with a sharp peak indicates a soil that is sensitive to changes in moisture content.

Variations in the Moisture-Density Relationship (1015.01.E)

To truly understand the moisture and density relationship as it relates to soil compaction, the project personnel should understand what items affect this relationship. This section briefly addresses these issues.

This moisture-density relationship is affected by, but not limited to, the following conditions:

1. A change in the laboratory compactive effort, or a field compactive effort that is different from the laboratory testing compactive effort.
2. A temperature of the compacted soil that is near or below freezing temperature.
3. Coarse aggregate that is added or subtracted from the soil.

Changing the Compactive Effort (1015.01.E.1)

The AASHTO T 99 proctor test used to make the Department's moisture-density curves was originally made to simulate field compaction conditions. It uses a standard compactive effort that allows us to evaluate and compare the compaction and densities of different soils. What happens to this moisture-density relationship as you increase or decrease this compactive effort?

In Figure 1015.01.F, the compactive effort may be increased or decreased to change the maximum density as much as 10 to 15 lbs/ft^3 (160 to 240 kg/m^3). As the compactive effort increases, the curve shifts to the left and up along the same line of optimum. If the compactive effort is lowered, the compaction curve shifts to the right and down.

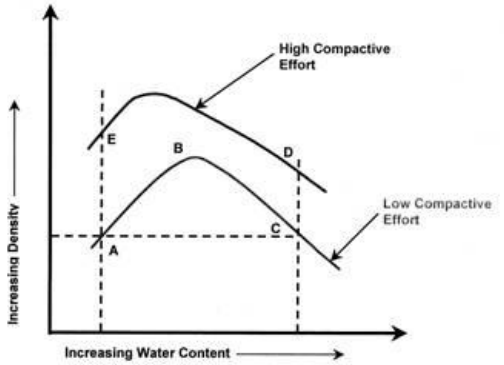


Figure 1015.01.F - Changing the Compactive Effort

Temperature Effects on Soil (1015.01.E.2)

If a soil is compacted at low temperatures, the maximum density cannot be achieved in the field. The specifications do not allow soil to be compacted that is frozen. In Figure 1015.01.G shows why this is the case. The maximum density can change as much as 10 lbs/ft^3 (160 kg/m^3) for soils compacted at temperature differences of 40º F (20º C). But, there may not be any difference in maximum density at all. Temperatures affect some soils but not others. There is not a formula that takes this temperature difference into consideration.

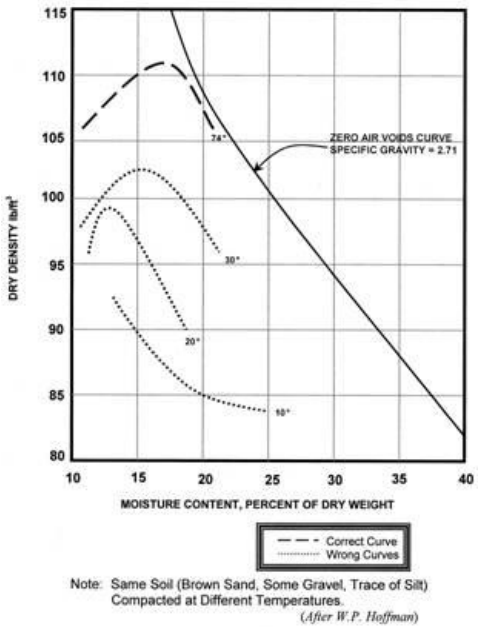


Figure 1015.01.G - Temperature Effects on the M-D Curve

Compaction procedures must be altered to check for this difference. Use the following procedure when the Contractor is compacting the soil at temperatures lower than 45º F (7º C) or when the site conditions warrant:

1. Take the normal proctor test during the compaction testing. Choose the curve associated with this compaction test.
2. Take enough soil from the same hole to make another proctor later. After the soil is warmed to approximately 70º F (21º C) make an additional proctor. Pick an additional curve using the wet weight of the second proctor and moisture content from a drying method.
3. Compare the two results and use the higher curve if there is a difference. Use this procedure at any time the material is suspect in the field.

Coarse Aggregate Problem (1015.01.E.3)

The moisture-density relationship is very good for soils passing the ¾ inch (19 mm) sieve as it relates to the field compaction of soils. There are problems when this relationship is extrapolated to soils larger than the ¾ inch (19 mm) sieve material or for granular soils. Corrections must be made to account for these materials. In certain circumstances, field densities do not correspond to the laboratory results. These will be pointed out in later sections.

Figure 1015.01.H details a plot of adding or subtracting coarse aggregate to a soil and the resulting change in the moisture-density curves.

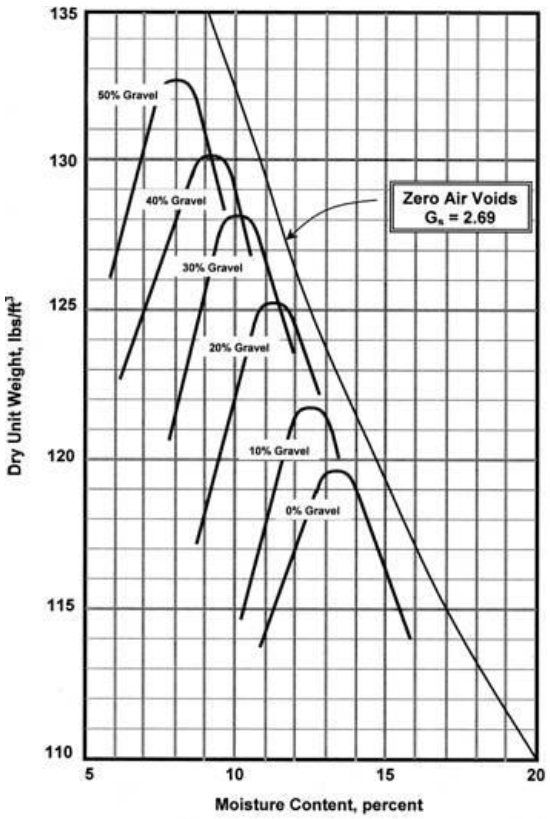


Figure 1015.01.H - Coarse Aggregate Effects on Soil M-D Curve

As you add gravel or plus ¾ inch (19 mm) material to the soil, the optimum moisture shifts to the left and the maximum density increases. The average increase in density is approximately 1 percent per 10 percent of material retained on the ¾ inch (19 mm) sieve. This effect is taken care of on the compaction form *CA-EW-6* and is fully explained in Section 1015.03 in this manual.

If you sieve the material through the ¾ inch sieve, remove 20 percent coarse aggregate, and do not consider this, you could easily be one or two curves lower than intended.

Use the correction on the *CA-EW-6* compaction form where more than 10 percent of the material is retained on the ¾ inch (19 mm) sieve. This correction usually increases the maximum density and also an optimum moisture correction is made.

Importance of Temperature and Coarse Aggregate Corrections (1015.01.E.4)

The accuracy of all compaction testing is important. But, the importance of making temperature and coarse aggregate corrections in the compaction testing are less obvious to the project personnel. Without these corrections the compaction testing could easily be off by more than 2 lbs/ft^3 (32 kg/m^3) without the project personnel being aware of a problem.

If the compaction testing is off by 2 lbs/ft^3 (32 kg/m^3), or approximately one Ohio Typical Density Curve, this may result in a loss of 15 percent of the soil strength. If the testing is off by two curves, the potential loss could be 30 percent, and so on. The strength may not be apparent in construction, but in the long term it may have devastating effects on the performance of the embankment.

Estimating Optimum Moisture (1015.01.F)

Soil Boring Interpretation Method

All cohesive soils are compacted at water contents less than the plastic limit of the material. For A-7-6 soils, the optimum moisture content is around the plastic limit minus 3. For A-4 and A-6 soils, the optimum is around the plastic limit minus 5. The optimum moisture content of granular materials ranges between 5 and 10, and for non-plastic silts is around 11.

You can obtain an estimate of the consistency of the material by using the above information and looking at the soil's water content from the soil borings before the work begins. Keep in mind the water content on the soil borings is the water content at the time the borings were drilled. They should be considered an estimate of the present field conditions.

You can approximate the optimum moisture of a material by the feel of the material in the field, using one of the following methods.

Hand Squeeze Method

Take a sample of the material in question in your hand.
Squeeze the material together and let go.

Consult the following table:

If the material…	Then material is…
Falls apart in small pieces	Dry of optimum
Stays together	At or above optimum
Breaks into two or three large pieces	At optimum
Stays together and there is excess water on hands	Above optimum

Ball Method

Roll the material into a one-inch ball.
Place it between your thumb and index finger and squeeze the material.
Consult the following table:

If the material…	Then material is…
Ball cannot be formed	Below optimum
Becomes oval	Above optimum
Breaks apart into uniform pieces (Some clays will have larger pieces than silts)	At optimum

Spit Method

Spit on the material.
Consult the following table:

If the saliva…	Then material is…
Beads up	Above optimum
Slowly sinks in	At optimum

Use these methods as estimates; they do not replace compaction testing. These estimates are different for each type of soil (clay, silt, granular).

Compaction Testing of Soils (1015.02)

General (1015.02.A)

Proper compaction at the proper moisture is the most effective and most economical way to improve the stability of soils. Satisfactory performance of pavement and embankment depends on the good compaction of the embankment and subgrade materials. Careful control is necessary to ensure compliance with the specification compaction requirements for embankments and subgrades.

The density test is the principal means by which the Engineer determines whether or not the specified compaction requirements have been met. The number of tests to be made for a given quantity of embankment material placed is set by Supplement 1015.10. The Engineer has broad powers to increase or decrease this testing depending on the field conditions. The Engineer may use his or her judgment to make tests at locations where the information is most needed for proper control.

For example, consider an area of embankment under construction where the soil and moisture conditions are uniform and ideal for good compaction, and where previous compaction tests have shown that the specification requirements are being met consistently under the same number of roller passes. As long as inspections show

that the uniform conditions of soil, moisture, lift thickness, and roller pass continue for this area, only occasional check tests for compaction are required.

Where relatively few tests are made because materials and conditions are uniform, document this by describing conditions on the Compaction Forms or other appropriate project records. Avoiding a large number of tests in areas of uniform condition where specified compaction is consistently obtained allows the project personnel to concentrate their effort on other areas of the project where conditions are less uniform or suspect.

Tests must be made in areas where inspection indicates that the material is questionable even if specified compaction is being obtained. Evidences of questionable compaction, which can be determined by inspection, include the following:

1. Low number of roller passes to obtain compaction.
2. Excessive deflection under heavy construction equipment.
3. Using lightweight rollers.
4. Very wet or dry soil.
5. Areas compacted without full time inspection.
6. Inconsistent materials, such as shale and rock mixtures, or recycled concrete mixed with soil.

The observation that a sheepsfoot roller will “walk out” or “ride high” on a layer of hard, dry soil is not evidence of satisfactory compaction. This soil may be stable when dry but weak when wet.

Areas where it has been determined that compaction or moisture does not meet specification requirements must be corrected before the next lift of embankment is placed.

The Engineer must give specific directions to the inspectors. These directions must cover the inspector’s responsibility and authority given to them by the Engineer. This ensures that timely decisions are made in the field and that full compliance with the contract requirements is obtained on the project.

Control of compaction includes making moisture and density determinations for establishing whether the compaction meets the requirements prescribed in the specifications.

A sufficient number of tests must be made to ensure that construction complies with the specifications. The nuclear gauge method is the only method used for compaction testing. The sand-cone, rubber-balloon, and cylinder density tests have been eliminated.

Regardless of the method chosen, a one-point proctor test is used to identify the curve that represents the soil in question for each compaction test, except for materials requiring a test section.

Equipment (1015.02.B)

1. Equipment listed in Section 1015.01.B.1.
2. A 3-inch (75 mm) or 4-inch (100 mm) post-hole auger.
3. A container with a 4.5-inch (114 mm) hole cut in the bottom.
4. Troxler 3440 Nuclear Gauge.
5. 25 to 50 lbs (12 to 23 kg) of dry uniform natural sand passing the No. 10 (2 mm) sieve.
6. Form *CA-EW-5*, “Nuclear Gauge Compaction Form” and Form *CA-EW-6* Nuclear Gauge Compaction with an Aggregate Correction.

Preparation of Test Site (1015.02.C)

Select a location for the density test that is representative of a rolled area of the embankment layer being constructed. If loose, uncompacted material, such as results from sheepsfoot rolling, exists on the surface, remove the loose material to expose the compacted material underneath. Carefully level the test area by any convenient means, such as a dozer, grader, hand shovel, straightedge, etc.

Compaction Testing of Soil Using a Nuclear Gauge (1015.02.D)

The Department uses nuclear equipment manufactured by Troxler Laboratories. Presently the Department uses the 3440 series gauges. The operator should have a Manual of Operation for the gauge.

There is no radiological danger for the operation of a nuclear gauge so long as the correct operating and safety rules are followed. Each operator is issued a specific set of instructions governing safety when the gauge is assigned to him or her. For more information about the safety requirements see the following link to the Nuclear Labs Web site:

www.dot.state.oh.us/Divisions/ConstructionMgt/Materials/Pages/Radiation-Safety.aspx

In addition, contact the Nuclear Lab at (614)275-1375 for more information.

For nuclear measurement of density, gamma rays emitted into the soil from a gamma source are scattered by the electrons in the soil and lose energy in the process. The number of scattered rays returned and counted in the gauge depends on the average length of the path of the ray between the detector and source. The electron density increases proportionally with the density of the soil and causes greater scattering and energy loss. Therefore, the chances that scattered gamma rays returning to the detector with sufficient energy to be counted become smaller with increased soil density, and the count rate drops. In common types of soils, a low gamma ray count indicates a high density, and a high count indicates a low density.

For nuclear measurements of moisture, the neutron energy absorption technique measures the moisture content of rock or soil materials. The nuclear method for measuring the moisture content of soil and rock materials is based on the principle of measuring the slowing of neutrons emitted into the soil from a fast-neutron source. The energy loss is much greater in neutron collisions with atoms of low atomic weight, and is directly proportional to the number of such atoms present in the soil. The effect of such a collision is to change a fast neutron to a slow neutron. Hydrogen, which is the principal element of low atomic weight found in soils, is contained largely in the molecules of water in an inorganic soil. The number of slow neutrons detected by the gauge, after an emission of fast neutrons from a radioactive source, is counted electronically in the gauge. The count obtained by the gauge is proportional to the amount of water in the soil or rock.

Density and moisture determinations can be made in any of the following two positions relative to the material being tested:

1. Backscatter - Source and detector in the gauge are resting on the surface of the material being tested.
2. Direct Transmission - Source in the rod is extended below the gauge into the material being tested, and the detector in the gauge is on the surface of the material being tested.

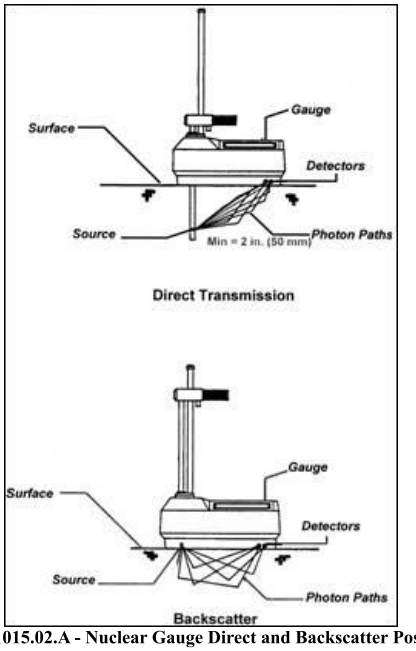


Figure 1015.02.A - Nuclear Gauge Direct and Backscatter Positions

Moisture-Density Testing (1015.02.D.1)

Use form *CA-EW-5* or *CA-EW-6* for moisture-density testing when using a nuclear gauge. The following is a summary of the gauge operations when testing soils. Consult the owner's manual of procedures more detailed explanation. The gauge is self-driven throughout the process. The operator pushes a button and the gauge asks a question or gives an answer.

1. Determine the standard count

a. Perform at least every week or when the test location changes.
b. Put the gauge on the standard block with the handle opposite the metal plate. See Figure 1015.02.B.

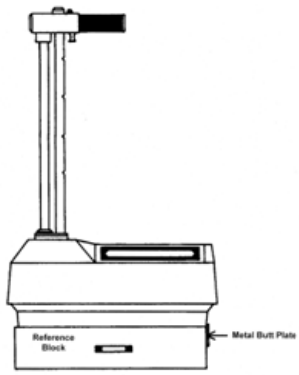


Figure 1015.02.B - Nuclear Gauge on the Standard Block

c. Make sure the standard block is resting on material which weighs more than 100 lbs/ft3 (1600 kg/m3).
d. Press the "ON" button on the gauge panel (see Figure 1015.02.C).
   i. Wait approximately 4 minutes for the gauge to "warm up."
   ii. Gauge may already be on prior to placing it on the block.
   iii. The gauge will beep when ready.

YES EXIT	NO/CE C/CE	STATUS 7	MODE 8	SPECIAL 9
STORE MS	OFFSET MR	PROJECT 4	PRINT 5	ERASE 6
PROCTOR/ MARSHALL +	TIME -	COUNTS 1	DEPTH 2	CALC. 3
SHIFT X	STANDARD +	RECALL 0	. .	START/ ENTER =

Figure 1015.02.C - Nuclear Gauge Keypad

   iv. Readout:
      1. Depth: Safe Position
      2. Time: 1 min. (possibly a longer duration)
      3. Battery: Volts
e. Press the Standard Button:
   i. Readout
      1. Do you want to take a new standard?
      2. Press "YES"
      3. Is the gauge in the safe position?
      4. Press "YES"
   ii. Readout:
      1. Taking a standard count.
      2. Takes 240 seconds.
      3. Gauge will beep when complete.
   iii. Readout when standard count is complete:
      1. MS XXXX X.X%P
      2. DS XXXX X.X%P
      3. P-Pass, F-Fail

4. If reading is within 1% for density or 2% for moisture, the standard passed.

f. Record standard count on lines 4 and 7 on the *CA-EW-5* and lines 1 and 2 on the *CA-EW-6*.

g. Do you want to accept the new standard?

i. Press "YES" if acceptable.

ii. Readout

1. Ready
2. Depth
3. Volts
4. Ready to take the readings.

2. Taking Nuclear Gauge Readings

a. Clear away all loose material or dried crust.

i. Obtain a level area with sufficient size to accommodate the gauge.

ii. Use the scraper plate to help smooth out the surface.

iii. See Figure 1015.02.D

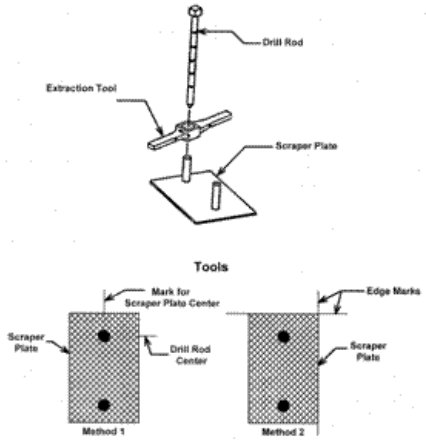


Figure 1015.02.D - Scraper Plate and Use

b. Use the native fines or fine sand to fill the voids to finish smoothing out the surface.

i. The maximum void beneath the gauge should not exceed 1/8 inch (3 mm).

c. Make a hole perpendicular to the prepared surface by using the pin (drill rod) provided by the manufacturer.

i. Drive 2 inches (50 mm) further than the depth of the reading.

d. Mark the outside of the scraper plate.

e. Remove the scraper plate and position the nuclear gauge on the prepared location.

i. Raise the gauge up on one side and extend the rod out about 2 inches (50 mm).

ii. Place the rod over the hole and extend the rod the rest of the way.

f. Extend the rod to the required depth. See Figure 1015.02.E.

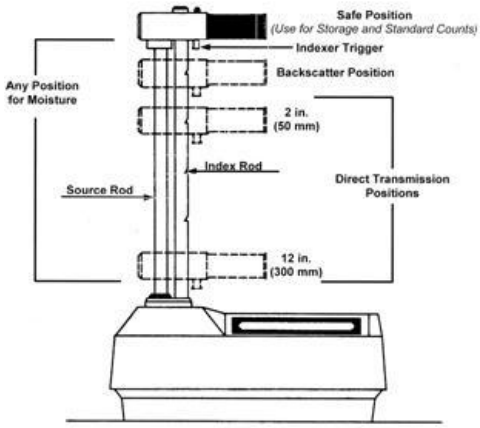


Figure 1015.02.E - Positions of the Nuclear Gauge

i. Backscatter Position is used for:
    1. Bases.
    2. Granular Materials.
    3. Materials requiring a Test Section.
ii. 8-inch (200 mm) depth used for Embankment.
iii. 12-inch (300 mm) depth used for Subgrade.
iv. The gauge gives the depth.
v. The deepest depth is the most accurate.

g. Pull the gauge toward the detector end or away from handle to seat the gauge into position (see Figure 1015.02.A).
    i. Eliminates the air gap between the source rod and the hole.

h. Press "START/ENTER".

i. After one minute:
    i. Readout
        1. DD = Dry Density = Line 6= 133.0 lbs/ft3
        2. WD = Wet Density = Line 5 =144.4 lbs/ft3
        3. % M = % moisture = Line 8 = 8.3%

j. Record information on Lines 5, 6, and 8 of the *CA-EW-5* Form and on lines 3, 4, and 5 on the *CA-EW-6* Form.

k. See Figure 1015.02.F
    i. DD = Dry Density = Line 6= 133.0 lbs/ft3
    ii. WD = Wet Density = Line 5 =144.4 lbs/ft3
    iii. % M = % Moisture = Line 8 = 8.3%

Using the Ohio Typical Curves (1015.02.E)

Optimum moisture and maximum dry weight can be determined from the proctor test results, nuclear gauge results, and the Ohio Typical Density Curves as described in Section 1015.01.C and 1015.01.D. Use the Plotted Ohio Typical Density Curves for the compaction testing, that are in the Forms section of this manual.

Once the wet weight and percent moisture is obtained from the proctor test, it can be used to find the curve that represents the soil being tested. Use nuclear method or drying method to determine percent moisture in lieu of the penetration resistance method; do not use the penetration resistance method.

CA-EW-5
02/03/03

STATE OF OHIO
DEPARTMENT OF TRANSPORTATION
NUCLEAR GAUGE COMPACTION FORM

Sample ID: 1113722540-416 Personnel ID: 111 - 0000 - 111 Date Sampled: 04 / 16 / 00
Type of Inspection: COMPACTION Producer Code: 60555 - 2 Contractor: Dave's Excavating
Material Code: 203A0001 Test Results: PASS

Project Number: Item Code: Reference Number:
Notes:

Test of (check which): ☒ Embankment ☐ Subgrade ☐ Base ☐ Other: Min. Compaction Req.: 98 %
Test of (check which): ☐ Limestone ☒ Gravel ☐ Slag ☐ Sandstone ☐ Granulated Slag ☐ Other:
From Sta. 1 + 00 at 5 feet (Rt or lt.) of centerline to Sta. 2 + 00 at 10 feet (Rt or lt.) of centerline, at approx. Elevation 970 ft
See Report No. (check which): Wet ☐ Dry ☒ Maximum Density from Test Section lb/ft³ Optimum Moisture %
98% of Max. Density: lb/ft³ Check Method used: ☒ Direct Transmission ☐ Backscatter Probe Depth: 8 inches

		1.	2.	3.	4.	5.	6.
1. Station of test	1.	109 + 50	109 + 50				
2. Distance (Rt or left of centerline if different than above (ft)	2.	10	12				
3. Approximate Elevation if different than above (ft)	3.						
Procedure for Determining Dry and Wet Density							
4. Standard Count for Density	4.	7008					
5. Wet Density of soil from gauge (lb/ft³)	5.	139.9	144.4				
6. Dry Density of soil from gauge (lb/ft³)	6.	120.1	133.0				
Procedure for Determining Moisture Content							
7. Standard Count for moisture	7.	3586					
8. Moisture content of soil from gauge * (%)	8.	7.5	(8.3)				
9. Number of Passes	9.	8	10				
Take sample (about 10 lb) of material from area tested for density. Procedure when sample contains less than 10 % total weight in stone retained on 3/4" sieve**		Curve D	Curve D	Curve	Curve	Curve	Curve
10. Weight of 1/30 ft³ compacted wet soil + weight of container (lb)	10.	13.05	14.01				
11. Weight of 1/30 ft³ container (lb)	11.	9.24	9.24				
12. Weight of 1/30 ft³ compacted wet soil (#10 - #11) (lb)	12.	4.73	4.77				
13. Density of compacted wet soil (30 x #12) (lb/ft³)	13.	141.9	(143.1)				
14. Optimum moisture from dry density curve, Curve No. (D) (%)	14.	8.5	8.5				
15. Maximum Dry Density ,Curve No. (D) (lb/ft³)	15.	134.1	134.1				
16. Amount above ☐ or below ☐ optimum moisture (#14 - #8) (%)	16.	+ 1.0	- 0.2				
17. Compaction [(#6 ÷ #15) x 100] (%)	17.	97.0	99.2				
18. Moisture from the zero air voids curve using line 6	18.	10.6	9.5	8.5 ± 8.3 ✔	OK		
19. Does material tested meet Specification requirements? Yes ☐ No ☐	19.	NO	YES				
20. "A" Rolling ordered; "B" Aerating ordered; "C" Watering ordered	20.	A					
21. Date Tested	21.	08 / 22 / 92	08 / 22 / 92				

* In percent of Dry Density. ** Refer to CA-EW-6 when sample contains more than 10 % total weight in stone retained on 3/4" sieve.

Computed By: SCOTT COMPACTION Checked By DIRECTOR GALLAGHER
DOT-1635

Figure 1015.02.F - Completed CA-EW-5 Compaction Form

Selecting a Typical Curve Using the Nuclear Gauge Results (1015.02.F)

1. Secure a representative soil sample of about 10 lbs (5 kg).
    a. Use the soil between the end of the probe and the back of the gauge (see Figure 1015.02.A).
2. Sieve the material through a 3/4 inch (19 mm) sieve.
    a. Use Form *CA-EW-5* if less than 10% of the soil is retained.
    b. Use Form *CA-EW-6* if more than 10% of the soil retained.
    c. Use a Test Section Method if more than 25% is retained.
3. Thoroughly mix the material passing the 3/4 inch (19 mm) sieve.
4. Make a Proctor using section 1015.01.B.2 of this manual.
    a. Make a proctor test for every compaction test (a soil cannot be correctly identified without this test).
    b. When weighing the proctor mold and soil, the scales must be level and balanced.
        i. The scales need to be leveled with a carpenter's level. Put the scale on a piece of flat plywood then level the board. You may elect to level the weighting plate.
        ii. The older scales must also be balanced once it is leveled. The weighting mechanism should float between the top and bottom bar. If it does not then sand or pebbles can be added to the lever arm to make it balance.
5. Record and calculate the 'Proctor' results on Lines 10 through 13 on the *CA-EW-5* and lines 11-14 on the *CA-EW-6*.
    a. Use Figure 1015.02.F
    b. Line 10 (14.01 lbs) – Line 11(9.24 lbs) = Line 12 (4.77 lbs)
    c. Line 12 (4.77 lbs) × 30 = Line 13 (143.1 lbs/ft3)
6. Pick the Wet Weight Curve Using
    a. The proctor wet density.
    b. Line 13 = 143.1lbs/ft3
    c. Moisture from gauge readings or by another drying method.
    d. Line 8= 8.3%
7. Use the printed Ohio Typical Density or Project Curves (see Figure 1015.02.G).
    a. Draw a horizontal line through the wet weight per cubic foot (cubic meter) on the Ohio Typical Density Curves from the proctor weight on Line 13 on the *CA-EW-5* or Line 14 on the *CA-EW-6* Form.
        i. Line 13 = 143.1 lbs/ft3
    b. Extend a vertical line from the percent moisture shown on Line 8 on the *CA-EW-5* or Line 5 on the *CA-EW-6* Form, to intersect the horizontal line.
        i. Line 8 = 8.3%

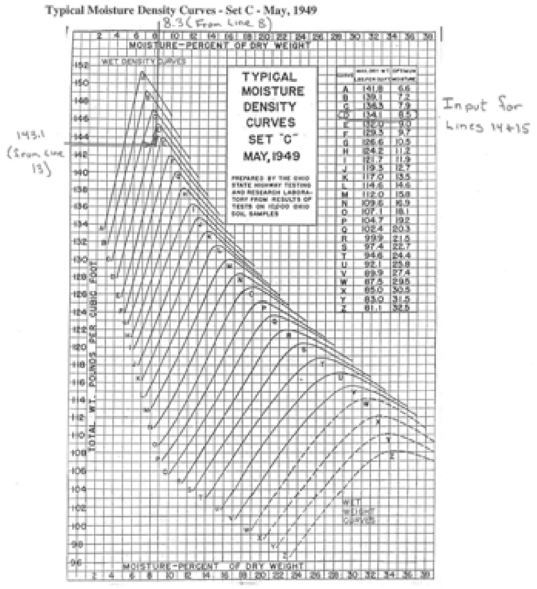


Figure 1015.02.G - Example of Using the Ohio Typical Density Curves

c. If the intersection falls on a curve, choose the curve.
d. If the intersection falls between two curves, choose the next highest curve.

8. Use the Maximum Dry Weight and Optimum Moisture data in the upper right hand corner of Figure 1015.02.G from the curve that is chosen.
   a. In this example curve 'D' is the correct curve.
9. After the curve is selected, record optimum moisture on Line 14 and the maximum dry density on Line 15 of Form CA-EW-For the *CA-EW-6* record the optimum moisture on Line 15 and the maximum dry density on Line 18.
   a. Line 15 = Maximum Density = 134.1 lbs/ft3
   b. Line 14 = Optimum Moisture = 8.5%

Calculating Compaction and Zero Air Voids (1015.02.G)

Use Figure 1015.02.F

1. Use line 16 to calculate the difference in moisture contents.
   a. Line 14 = 8.5% - Line 8 (8.3%) = - 0.2% (below optimum)
2. Use line 17 to Calculate Compaction.
   a. (Line 6/ Line 15) × 100 = (133.0 lbs/ft3/ 134.1 lbs/ft3) × 100 = 99.2%.
3. Compare to the allowable in the specifications shown in Table 203.07-1.

Table 203.07-1 Embankment Compaction Requirements

Maximum Laboratory Dry Weight (lb/ft^3)	Minimum Compaction (percent)
90 to 104.9	102
105 to 119.9	100
120 and more	98

   a. Since Line 15 = 134.1 lb/ft3 > 120 the minimum required compaction is 98%.
   b. Line 17 = 99.2% > 98
   c. The test passes.
4. If density and stability are achieved, then moisture passed.
   a. See Procedures Manual Section *203.07*.
5. Check zero air voids.

a. Use Figure 1015.01.02.H.
b. Use line 6 = 133.0
    i. Get 9.5
c. 9.5% > Line 8 = 8.3%
d. Good (Line 8 may be a maximum of 1% above the Figure 1015.02.H value.)

Can calculate the percentage by using the formula in Figure 1015.02.H

    i. Where G=2.67 and D = line 6
    ii. The formula is much easier to use than the graph if you are good with math.

6. The check on the zero air voids is a check on the nuclear gauge readings. The moisture obtained from the curve or graph is the maximum moisture that can exist in the soil being tested. If the gauge moisture readings are larger than the ones obtained from the graph then an error may exist in the test.

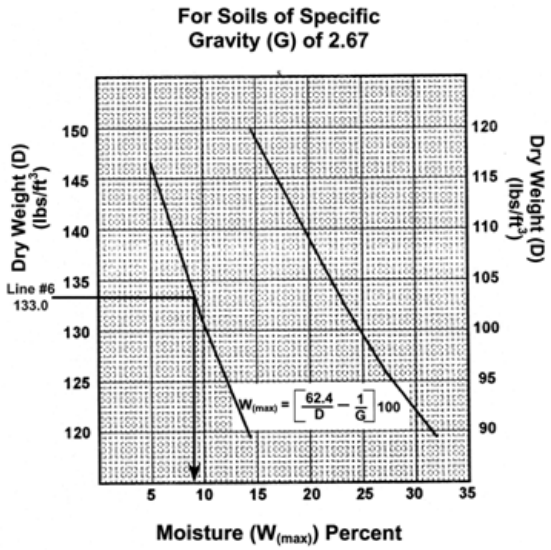


Figure 1015.02.H - Zero Air Voids Curve

Moisture Controls (1015.02.H)

Moisture Control of Soil Embankments during Construction (1015.02.H.1)

This section discusses moisture controls during construction, details some of the variables in the moisture controls, and discusses alternate methods used to verify or modify the moisture readings from the nuclear gauge.

Experience has shown that to obtain the specification density, the moisture content must be at or near optimum. Some soils, particularly silty soils with low plasticity, may meet the moisture (± 3 percent from optimum) and the compaction requirements but have unsatisfactory stability.

Some soils compact better and meet the density and stability requirements at minimum moisture of -3 or more below optimum. The reason for limiting the moisture contents for soil embankment this way is to ensure stable embankments.

The “Elasticity and Deformation of Soils” is discussed in Section *203.02* and “Moisture Controls” are discussed in Section *203.07.A* of this manual.

There is not a numerical moisture requirement in the specifications. The Contractor must compact the material at a moisture content to obtain the density and stability of the material. Moisture and compaction controls are

necessary to secure the quality of embankments and subgrades that are essential for the long life and performance.

Alternate Tests for Moisture (1015.01.H.2)

The specifications do not numerically limit the moisture content of embankment or subgrade soils. Moisture determinations must be made in the field to pick the required moisture-density curve and to control the Contractor's compaction operations. The following sections deal with various methods of determining moisture contents of soils.

For engineering purposes, the moisture of soil is expressed in percent of dry weight.

$$\text{Percent Moisture} = \frac{\text{Weight of water in soil}}{\text{Weight of dry soil}} \times 100$$

Most of the time, the moisture of a soil should be obtained by using the nuclear gauge readings. However, there are situations where drying methods can and should be used. Moisture content is the most variable reading from the nuclear gauge. There are varieties of chemicals in the soils that can minimize the moisture content reading reliability. This is particularly true for recycled materials such as fly ash, bottom ash, foundry sand, or asphalt.

Use the moisture estimating principles detailed in section *203.02*, "Estimating Optimum Moisture." This section guides the determination of an alternate moisture measurement.

For each drying method the soil to be tested should be a representative sample of at least 1 pound (0.5 kilograms). The soil should be placed in a small, clean can or jar and covered with a tight lid at the construction site, to prevent evaporation of moisture while moving to the location of the test. The test should be conducted as soon as possible after taking the sample. Location where sample is taken must be noted.

All the moisture tests should be checked against each other to ensure accuracy of the moisture testing. To record the moisture results use Figure 1015.01.B, "Moisture-Density Calculation Form" and read the appropriate sections.

Oven-Drying Method (1015.02.H.3)

This method of determining moisture content is applicable to all types of soils. The time required to dry the sample depends on the size and moisture content of the sample and the type of soil.

This method should be used for any recycled material. This can be used to apply a moisture correction to the nuclear gauge readings when the material is uniform. This is particularly true for fly ash.

Equipment

1. Two-burner stove. Either oil stove or a camp stove using white gasoline.
2. "Boss 75" portable oven, or equivalent.
    a. This oven measures approximately 20 inches (0.5 meters) high, 20 inches (0.5 meters) wide and 13 inches (0.3 meters) deep.
    b. It sets on and is heated by the stove.
3. Several baking pans approximately 12 × 8.5 × 2.5 inches (300 × 200 × 63 mm).
4. Masonry trowel or putty knife.
5. Can of fuel. Can has tight stoppers and is painted red if used for gasoline.
6. Scale of 25-pound (12-kilogram) capacity sensitive to 0.01 pound (1 gram).
7. Piece of flat glass or pieces of bond paper with texture similar to the compaction forms.

Procedure

1. Weigh the pan to the nearest 0.01 pound (1 gram). Record the weight.
2. Place approximately 1 pound (0.5 kilograms) of representative sample of wet soil in the pan on the scale.
    a. Record the combined weight.
3. Break up all lumps of soil with the putty knife or trowel and avoid any loss of the sample.
4. Place the pan with the sample in the oven with the stove on. Stir the soil every 3 to 5 minutes.
5. After the soil has changed to a lighter color and appears to be dry, remove the soil sample from the oven and test to determine if it is completely dry by using one of the following methods:
    a. Lay a piece of bond paper approximately 2 × 3 inches (50 × 75 mm) on the sample.
        i. If the paper curls immediately when laid on the sample, the soil contains moisture.
        ii. The paper used for this test must be bond of hard surface texture like the paper used for the compaction forms.

b. Hold a piece of clean glass or a mirror in a horizontal position about 1 inch (25 mm) above the soil sample.
    i. If the glass steams up, this is an indication of further moisture in the sample.
c. Keep the glass away from the heat of the stove or direct rays of hot sun prior to the test since this test depends upon condensation of moisture in the hot air onto the cooler glass.

6. If the test indicates further moisture is in the sample, stir the sample and continue drying.
    a. Test the soil every 3 to 5 minutes until the test indicates the soil is dry.
7. Weigh the dried sample and pan to the nearest 0.01 pound (1 gram). Record this weight.
8. Subtract the weight of the pan from the weight of the pan and the dry sample to obtain the weight of the dried sample.
9. Subtract the weight of the dried sample from the weight of the wet sample. This is the weight of water in the original sample.
10. Divide the weight of the water by the weight of the dried sample. Multiply this result by 100. This gives the percentage of moisture in the sample. The equation is:

$$\text{Percent Moisture} = \frac{\text{Weight of wet soil} - \text{Weight of dry soil}}{\text{Weight of dry soil}} \times 100$$

Open-Pan Drying Method (1015.02.H.4)

This method is quick, simple, and obtains accurate results for granular material. This method should not be used for fine-grained soils (silts or clays) because the high temperatures may burn away the organic material if it happens to be present. This method can be used for fine-grained soils where limited accuracy is satisfactory and approximate moisture results are acceptable.

This method should not be used for any recycled material. It has been found to give lower moisture contents than is really in the material. This is particularly true for fly ash.

Equipment

1. Scale of 25 lb (12 kg) capacity sensitive of 0.01 lb (1 gram).
2. Several baking pans approximately 12 × 8.5 × 2.5 inches (300 × 200 × 63 mm).
3. Putty knife or other device for breaking up and stirring the soil.
4. Two-burner stove burning white gasoline.
5. Piece of flat glass or pieces of hard surface bond paper with texture similar to the compaction forms.

Procedure

Follow steps outlined in Section 1015.02.H.3 Oven-Drying Method Steps A thru L, except place the pan directly over the burner instead of in the oven.

Precautions

The following cautions should be taken to avoid introducing errors into the test.

1. Avoid overheating the soil.
    a. Use two pans, one inside the other, to avoid hot spots that may occur when a single pan is used.
2. Avoid baking the soil.
    a. Baking can be prevented by testing the material with a paper or glass test at sufficiently close intervals, so that further heating can be discontinued after all the moisture has been evaporated.
3. Ensure that no soil is lost during the test.

Alcohol-Burning Drying Method (1015.02.H.5)

This method is quick and simple. The alcohol burns at a low enough temperature 286º F to 320º F (140º C to 160º C) so that it can be used with accuracy for most soil types.

This method should be done outside or in a well-ventilated area.

Equipment

1. Scale of 25 lb (12 kg) capacity sensitive of 0.01 lb (1 gram).
2. 12 × 8.5 × 2.5 inches (300 × 200 × 63 mm) baking pan.
3. Pan or can with perforated bottom and filter paper to fit bottom.

a. A 10 oz (300 mL) round sample can is suitable for this purpose.

4. Glass stirring rod.
5. Supply of alcohol in tightly sealed can.

Procedure

1. Weigh perforated pan or can with filter paper in the bottom. Record weight.
2. Place sample of wet soil in perforated pan or can; weigh and record weight.
3. Place perforated pan or can in larger pan and stir alcohol into the soil sample with a glass rod until the mixture has the consistency of a thin mud or slurry.
    a. When stirring, do not disturb the filter paper on the bottom.
    b. Clean the rod.
4. Ignite the alcohol in the other pan and in the sample and burn off all alcohol.
5. Repeat the process three times, or until successive weighings indicate no reduction in weight, after each time burning.
6. After final burning, weigh perforated can or pan and dry soil, and record weight.
7. The weight of dry soil equals the weight minus weight of perforated pan or can and filter.
8. Calculate moisture content as shown in Section J though L of Section 1015.02.H.3.

Gasoline-Burning Drying Method (1015.02.H.6)

Application

This is a quick and simple method of drying. However, the gasoline burns at such a high temperature that it should be used only to dry granular materials. This method should only be conducted outside.

Equipment and Procedures

This method of drying is similar to the alcohol-drying method with the exception that the perforated pan and filter are not used. The gasoline can be mixed with the sample in the baking pan and burned in the pan. Except for this, the test is run exactly the same as the alcohol-burning method, described in Section 1015.02.H.5.

Compaction Testing Requiring an Aggregate Correction (1015.03)

The Aggregate Correction Problem (1015.03.A)

As detailed in Section 1015.01.E.3 “Coarse Aggregate Problem” the moisture-density relationship is very good for soils passing the ¾ inch (19 mm) sieve as it relates to the field compaction of soils. There are problems when this relationship is extrapolated to soils larger than the ¾ inch (19 mm) sieve material or for granular soils. Corrections must be made to account for these materials. In certain circumstances, field densities do not correspond to the laboratory results.

Figure 1015.03.A details a plot of adding or subtracting coarse aggregate to a soil and the resulting change in the moisture-density curves.

As you add gravel or plus ¾ inch (19 mm) material to the soil, the optimum moisture shifts to the left and the maximum density increases. The average increase in density is approximately about 1 percent per 10 percent of material retained on the ¾ inch (19 mm) sieve.

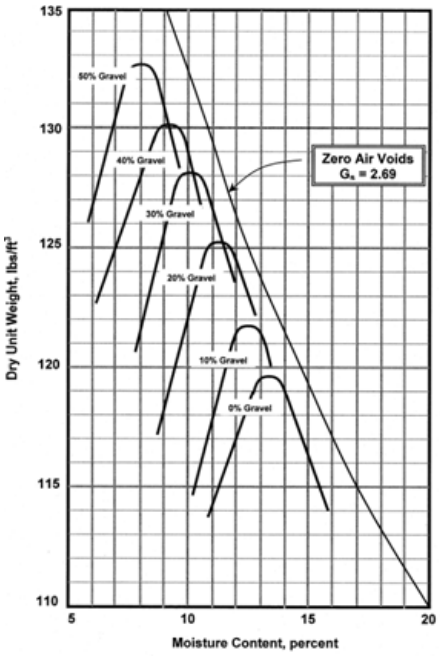


Figure 1015.03.A - Coarse Aggregate Effects

If you sieve the material through the ¾ inch sieve, remove 20 percent coarse aggregate, and do not consider this, you could easily be one or two curves lower than intended.

This correction usually increases the maximum density and an optimum moisture correction is made. This effect is taken care of on the compaction form *CA-EW-6*.

Use the correction on the *CA-EW-6* compaction form where more than 10 percent but less than 25 percent of the material is retained on the ¾ inch (19 mm) sieve. See Figure 1015.03.B, Aggregate Correction Method.

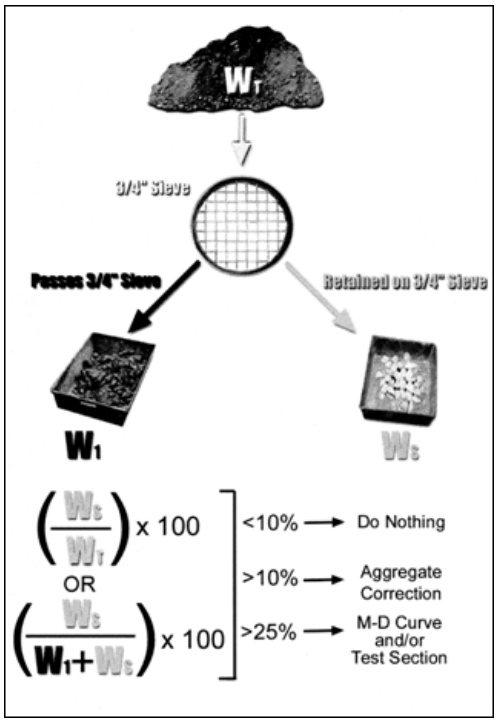


Figure 1015.03.B - Aggregate Correction Method

Caution: An, 'almost' pure sand may have between 10 and 25 percent retained on the ¾ inch sieve. A test section method would be used in this case. This method is to be used with 'Fine Grained Materials' with significant granular material retained not granular materials.

Using Form CA-EW-6 Nuclear Gauge Compaction with an Aggregate Correction (1015.03.B)

A completed Form is detailed in Figure 1015.03.C. The general sections of this form are as follows:

STATE OF OHIO
DEPARTMENT OF TRANSPORTATION
NUCLEAR GAUGE COMPACTION WITH AN AGGREGATE CORRECTION

Sample ID: _____ Date Sampled: _____
Type of Inspection: _____ Producer Code: _____ Contractor _____
Material Code: _____ Test Results: _____

Project Number _____ Item Code _____ Ref. Number _____

Notes _____

Test of (check which): ☐ Embankment ☐ Subgrade ☐ Base ☐ Other _____ Min. Compaction Req.: _____ %
From Sta _____ + _____ at _____ feet _____ (rt. or lt.) of centerline, at approx. Elevation _____ ft.

I. Nuclear Gauge Readings
1. Standard Count for Density _____ 1.= 2206
2. Standard Count for Moisture _____ 2.= 3690
3. Wet Density of the Soil from the Gauge _____ 3.= 129.1 lb/ft³
4. Dry Density of the Soil from the Gauge _____ 4.= 111.1 lb/ft³
5. Percent Moisture from the Gauge _____ 5.= 16.2 %

II. Remove the Soil from Under the Gauge and Sieve the Soil Through a 3/4" Sieve
6. Weight of wet soil (& stone if any) from hole + weight of pan _____ 6.= 14.0 lb
7. Weight of Pan or Container _____ 7.= 2.0 lb
8. Weight of wet soil (& stone if any) from under the nuclear gauge (#6 less #7) _____ 8.= 12.0 lb
9. Weight of stone & Sieve or Pan _____ 9.= 3.4 lb
9a. Weight of Sieve or Pan _____ 9a.= 1.0 lb
9b. Weight of stone removed from sample and retained on 3/4" Sieve (#9 less 9a) _____ 9b.= 2.4 lb
10. Percent stone in sample (9b ÷ #8 x 100) _____ 10.= 20.0 %

III. Proctor Test Using the Soil Passing the 3/4" Sieve
11. Weight of 1/30 ft³ compacted wet soil + weight of container _____ 11.= 13.40 lb
12. Weight of 1/30 ft³ container _____ 12.= 9.24 lb
13. Weight of 1/30 ft³ compacted wet soil (#11 less #12) _____ 13.= 4.16 lb
14. Density of compacted wet soil (30 x #13) _____ 14.= 124.8 lb/ft³

IV. Pick the Correct Curve from the Ohio Typical Density Curves Using #14 and (#5 or #16)
15. Optimum moisture from Dry Weight Curve (Curve_N_) _____ 15.= 16.8 %
16. Moisture from Line 5 or Corrected moisture by Drying if required _____ 16.= 16.2 %
17. Amount above ☐ or below ☒ optimum moisture (#16 - #15) _____ 17.= -0.7 %
18. Maximum Dry Density (From Curve No. 7L_) _____ 18.= 129.8 lb/ft³

V. Compaction Calculation Procedure When Line 10 is less than 10%
19. Compaction (#4 ÷ #18 x 100) _____ 19.= line 10 > 10% → Go to line 26

VI. Compaction Calculation When Line 10 is greater than 10% and less than 25%**
20. Corrected Maximum Dry Density using Graph A and Lines (#10 & 18) _____ 20.= 116.5 lb } Use Graph "A"
21. Corrected Optimum Moisture using line 20 and Typical Density Curves _____ 21.= 13.5 %
22. Compaction (#4 ÷ #20 x 100) _____ 22.= 95.4 %
23. Amount above ☒ or below ☐ optimum moisture (#5 - #21) _____ 23.= + 2.7 %
24. Moisture from zero air voids curve using (#4) _____ 24.= 18.0 % > 16.2 O.K.

*Average Specific Gravity Values: (Limestone = 2.6) Gravel = 2.5; Sandstone & Sandy Shale = 2.2
**If line 10 is greater than 25%, make a Gradation Moisture Density Curve and use the Test Section Method.

Does material tested meet specification requirements for: (write YES or NO on each of the following)
Max. dry weight: Yes ; Moisture: Yes ; Compaction: No :
Does test check zero air voids curve (check which): YES X NO
Action taken by (check which): Inspector _____ Project Engineer _____
If material tested does not meet specification requirements:
Additional rolling ordered ____ Aerating ordered ____ Watering ordered ____ Other
Computed By: _____ Checked By _____
DOT-1648

Figure 1015.03.C - Completed CA-EW-6 Compaction Form (pictures added for clarity)

I. Nuclear Gauge Readings

Lines 1 thru 5 are explained in Section 1015.02.D.

II. Remove the Soil from under the Gauge and Sieve thru a ¾ inch Sieve

This section is straightforward calculation of the stone retained on the ¾ inch sieve. Calculate through lines 6 through 10.

The percentage on line 10 is represented by the following equation:

$$\text{Percent of Stone in Sample} = \frac{\text{Weight of stone retained}}{\text{Weight of total soil sample}} \times 100$$

III. Proctor Test Using the Soil passing the ¾ inch Sieve

See Sections 1015.02.F section 'D' & 1015.01.B.2 for an explanation of Lines 11 thru 14.

IV. Pick the Curve for the Ohio Density Curves Using # 14 and (#5 or 16)

See Section 1015.02.F for an explanation of Lines 15 through 18.

V. Compaction Calculation When Line 10 is less than 10%

Line 19 is explained in Section 1015.02.G.

VI. Compaction Calculation When Line 10 is greater than 10% and less than 25%

This section uses Figure 1015.03.D Aggregate Correction Graph A and Figure 1015.03.E Moisture Correction with an Aggregate Correction to find a new Maximum Dry Density and Optimum Moisture.

The Nuclear Gauge Testing is almost the same as detailed in Section 1015.02 with the exceptions being the calculation of the Percent retained on the ¾ inch sieve in on line 10 in Section II and Section VI is new.

Calculate a New Maximum Dry Density

This section details Figure 1015.03.D Aggregate Correction Graph A:

The instructions are on the graph.

1. The inputs needed are:
    a. The Specific Gravity of the Stone Retained on the ¾" sieve.
        i. The typical values are listed on the graph.
    b. The Maximum Density Found on Line 18: 109.6 lb/ft3
    c. The Percent retained on the ¾ inch sieve on Line 10: 20%
2. Draw a line between the specific gravity and the Line 18 value.
3. Input Line 10 value on the bottom of the graph and draw a vertical to the previously line drawn.
4. Continue the line to the left on a right angle to the Corrected Maximum Dry Density.
5. Input this value found on line 20 on the *CA-EW-6*.

This is the corrected Maximum Dry Density: 116.5 lb/ft^3

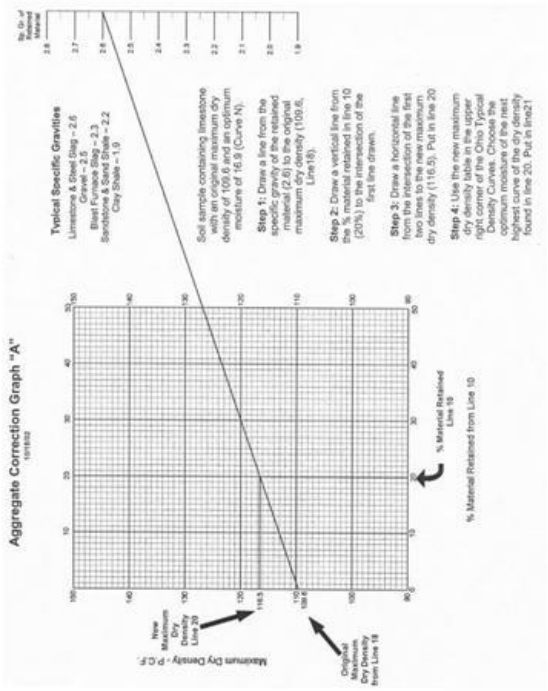


Figure 1015.03.D - Aggregate Correction Graph A

Determine a New Optimum Moisture

New optimum moisture is found by inputting the New Maximum Dry Density into the maximum Density Values in the upper right hand corner on Figure 1015.03.E.

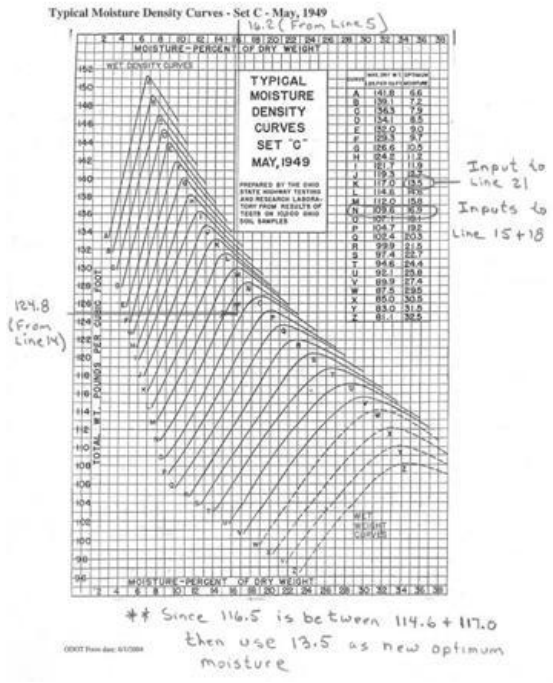


Figure 1015.03.E - Moisture Correction for an Aggregate Correction

For Example, the Maximum Dry Density on Line 20 is 116.5 lbs/ft^3. This value is between curve K (117) and L (114.5). New optimum value is 13.5% which is the moisture corresponding to the next highest curve which is Curve K.

<u>Compaction, Difference in Optimum Moisture and Zero Air Voids</u>

The compaction, difference in optimum moisture, and the zero air voids are calculated on lines 22 to 24. The calculation is the same as before.

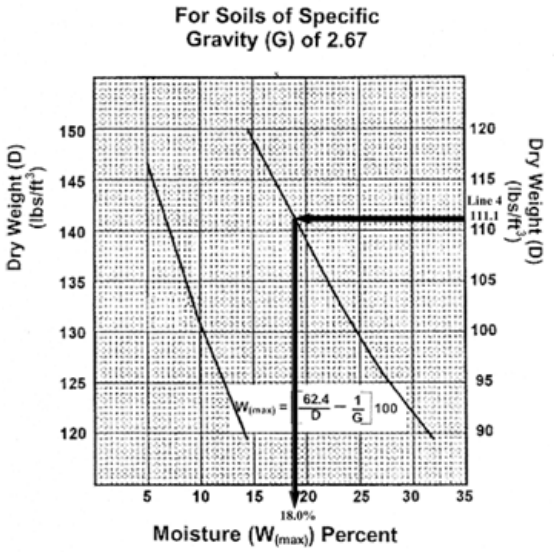


Figure 1015.03.F - Zero Air Voids curve

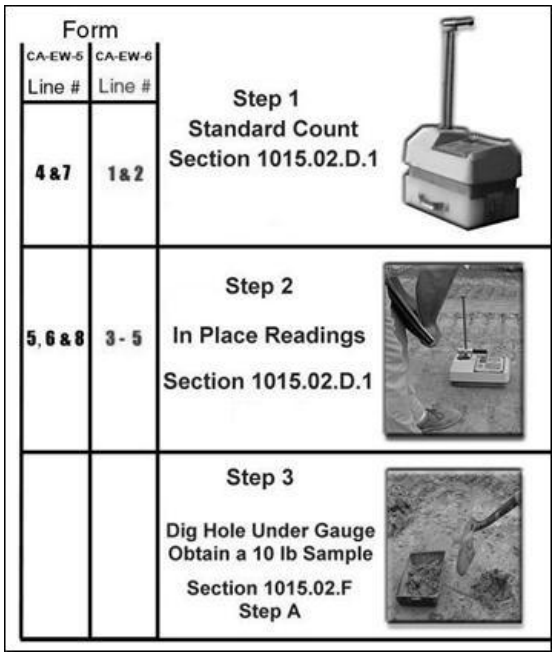


Figure 1015.03.G - Outline for Using Forms CA-EW-5 and CA-EW-6 (1 of 2)

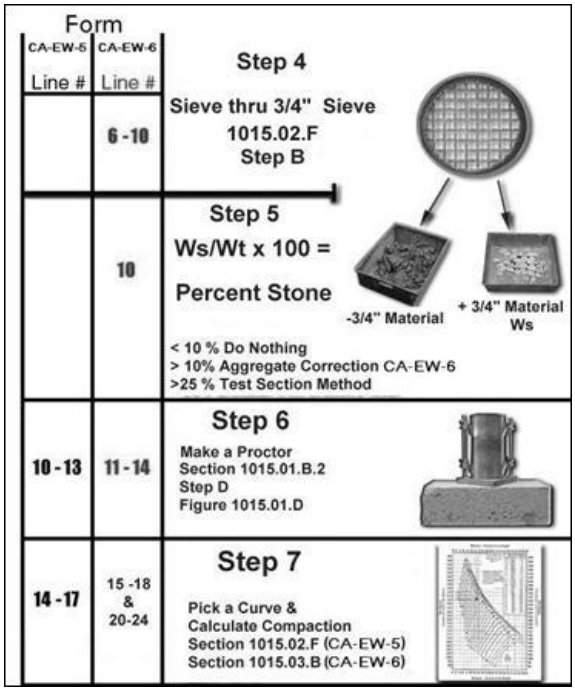


Figure 1015.03.H - Outline for Using Forms CA-EW-5 and CA-EW-6 (2 of 2)

1	Soil (8" lifts)	Sieve 3/4"	<10% Retained	A. One Point	
	Defined at >35% P-200		>10% Retained	B. Aggregate Correction	
			>25% Retained	C. Granular Material	See Granular
2	Granular Material < 35% P-200	8" Lifts	Moisture Density Curve	Test Section	Method A With Curve
	Examples: 304	Method A			Method B No Curve
	307	Method C			Method C Variable Material
3	Rock	3' Lifts or Largest Particle	18" Lifts near Bridges	Track and Fill Voids	Compact & Use Roller Passes
4	Rock & Shale Mixtures	8" Lifts		Compact like Shale	
5	Shale (8" Lifts)	Bucket Durability Test	< 25 % Retained in 3/4" Sieve	One Point	
			25-75 % Retained	Test Section	
			> 75 % Retained	Roller Passes	
				> 40 % Breaks Down	Test Section
				< 40 % Breaks Down	Roller Passes

Figure 1015.03.I - Compaction and Testing Guide

Compaction Testing for Granular Materials (1015.04)

General Explanation (1015.04.A)

This section describes how to perform compaction testing for materials used as granular soil, sand, structural backfill type 1 or 2, 304, 411, select granular backfill for MSE walls, granular material type A, B, C, D or F, or any materials that requires a test section.

The dry weight of the material is used for compaction control. The wet weight method is no longer used.

Moisture-Density proctor curves were originally developed for use on cohesive (clays and silts) soils. Errors or complications arise when trying to extrapolate these principles to other materials. This is the reason the Engineer or Inspector is given the latitude to choose density requirements that are based on the test section results.

A one-point proctor method using the typical density curves may be used for granular soils. The top curves of the Ohio Typical Density Curves A through E are usually chosen in this case. These curves will only work in a very limited number of cases. This method should only be used as a last resort.

These materials must have a moisture-density curve made a few weeks before the Contractor proposes to use the material. Curves may be made in the field or by the Laboratory.

Making a moisture-density curve for these materials is the same procedure explained in Section 1015.01.B. A typical moisture-density curve for a granular material is shown in Figure 1015.04.A.

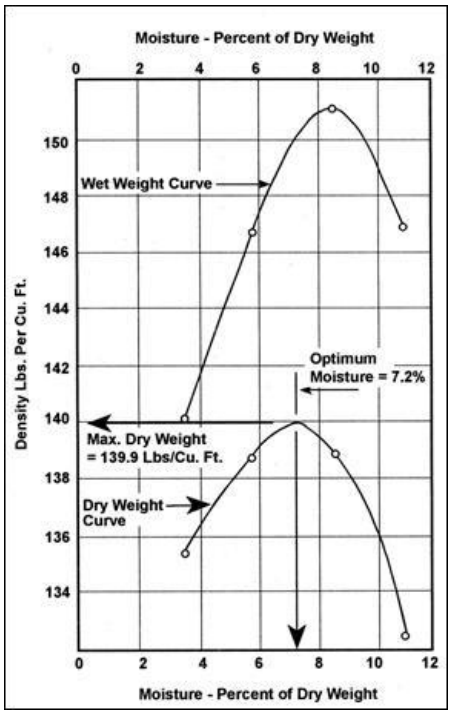


Figure 1015.04.A - Typical Granular Moisture-Density Curve

The district should contact the Office of Geotechnical Engineering at the following link to have a moisture-density curve made:

www.dot.state.oh.us/Divisions/ProdMgt/Geotechnical

The maximum density and optimum moisture data obtained from this curve may or may not work in the field. The following are examples and further explanation of some of the problems associated with the density control of these materials.

Examples of Density Problems (1015.04.B)

Using a Sandy Material (1015.04.B.1)

It may not be possible to obtain the maximum density of the curve no matter how or with what equipment the Contractor uses to compact the material. This is particularly true for sandy material with silt fines.

Reason

The proctor mold used to produce the moisture-density curve confines the sand in all directions. In the field, since sand doesn't interlock or knit together well without being confined, the roller will squeeze the material laterally. The proctor maximum densities may not be obtained in the field.

The sand may not even support the weight of the roller. The lab and field confining pressures and compactive effort are not compatible in this case.

This is shown in Figure 1015.04.B

Solution

Use the test section maximum density.

1015.04.B.2 Using a Well Graded Granular Material like 304

In this case, the maximum dry densities obtained in the field using the test section method often exceed the maximum dry density of the moisture-density curve.

Reason

The 304-type material is well interlocked and allows the roller to transfer more energy, compactive effort, or load to the material.

This roller load or energy is much larger than the proctor hammer load of 5.5 lbs. (2.5 kg) dropped 12 inches (305 mm) in three lifts.

This is shown in Figure 1015.04.B

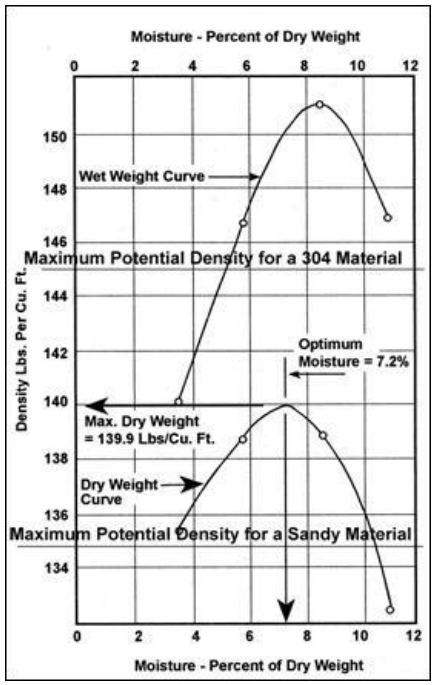


Figure 1015.04.B - Maximum Density Problems

Solution

Use the test section maximum density.

Compacting on a Soft Foundation (1015.04.B.3)

If the material is being compacted on a soft foundation, then the maximum density cannot be achieved. Excessive rolling will only result in pumping and creating an unstable foundation.

This applies to all types of materials. You cannot compact good material over bad material and expect to achieve a maximum density. You cannot compact material on jello-type material to a maximum density either. The maximum test section densities, if taken at all, would be less than the maximum curve value.

Compacting in Confined Spaces (1015.04.B.4)

There are a variety of locations where light equipment is used to compact material. Some examples are for:

1. Pipe backfill.
2. Manhole backfill.
3. Around abutments.
4. MSE walls.

The potential maximum density is limited to the type of equipment used to compact this material in these confined spaces.

Throughout the specifications for these items, ODOT requires minimum compaction equipment weight for these areas where a test section is used for compaction acceptance.

The maximum density that can be achieved is proportional to the heaviest equipment that can be used in these locations. The maximum density that can be achieved in these locations is usually less than the moisture-density curve value.

Moisture Problems (1015.04.C)

The granular material should be brought on site at or near optimum moisture. When this is not the case, moisture should be added before rolling occurs. This is particularly important for 304 gradation materials since this material cannot readily absorb water.

In *304.03*, it is required that the stockpile of 304 material have a moisture content of at least 2 percent below optimum.

Optimum moisture from the proctor moisture-density curve of granular materials is not always correct. Sometimes the granular material begins to roll or pump when the material is compacted at or near optimum moisture obtained from the moisture-density curve. This is caused by excess water in the material and the difference between the field and curve confining forces. In this case, dry the material until stability is achieved; usually 1 to 3 percent below optimum will work.

Summary of the Moisture-Density Problems (1015.04.D)

A granular moisture-density curve should always be used to estimate the maximum density and optimum moisture. When using these materials, the proctor moisture-density curve is used as a guide; the exact maximum density and optimum moisture can only be found in the field.

The test section method of compaction acceptance compensates for:

1. Material Differences.
2. Moisture-Density Curve and Potential Field Density Differences.
3. Moisture Problems.
4. Soft Foundations.
5. Confined Construction.

The maximum density determined in the field is relative to all of the above.

Equipment and Compaction Testing (1015.04.E)

The equipment used for compaction testing is the same equipment listed in 1015.02.B.

The compaction testing is the same as in section 1015.02.D, except for the following:

1. A proctor is not taken for every test.
    a. Only used to obtain the moisture-density curve.
2. The ‘Backscatter Mode’ on the gauge is used.
    a. Ensure that the surface voids are all filled or the surface texture is the same.
    b. Variation in the measurements will result.
3. Use Form *CA-EW-5*.

Minimum Roller Weights for Test Sections (1015.04.F)

Throughout the specifications, you will find minimum roller weight requirements when a test section method is used for acceptance.

The following is from C&MS *203.06.A*, page 92.

> *“For soil or granular material, when a test section is used, use a minimum compactive effort of eight passes with a steel wheel roller having a minimum weight of 10 tons (9 metric tons).”*

The following is from C&MS *603.11.E*, page 440.

> *“At the beginning of the work, construct a test section in the conduit trench. The Engineer will use at least 96 percent of the test section maximum dry density for acceptance of the production areas. Use at least the same number of passes or compactive effort used to construct the test section to compact the production areas. Use compaction equipment with a total weight or centrifugal force of at least 1/2 ton (0.5 metric tons). Supply the manufacture’s specification for the compaction equipment. Except when using a hoe pack, use at least six passes with the compaction equipment in the production areas.”*

The maximum potential obtained in the field is relative to the roller weight used in the test section. Therefore, minimums were established to fit the field conditions. You will notice that the confined areas have a much lower minimum weight and less maximum acceptance value.

Do not be confused by the word centrifugal force. It is only the effective weight when including the vibration of the equipment.

Procedure for Constructing a Test Section Method A (1015.05)

Method A is used when the moisture-density curve can be established to estimate the maximum density and optimum moisture.

The following is an outline of the procedure:

1. Test section size is 400 square yards.
2. Spread the material at the correct lift thickness.
    a. Usually 6 to 8 inches.
3. Moisture content at - 2 to + 2 of optimum.
    a. Water or dry throughout the lift.
    b. Reduce moisture if unstable.
4. Compact with two passes.
5. Take a compaction test.
    a. Mark the location with paint.
    b. Record on Line 6 of Form *CA-EW-5*.
6. Compact with one more pass and continue testing until:
    a. No further increase in density.
    b. Or the density decreases.
7. Once a maximum is obtained.
    a. Make two additional passes and take one additional test.
    b. Verifies the maximum value.(Verification Test).
8. Record the total number of passes.
    a. Use Line 9 of *CA-EW-5*.
9. Use this number of passes or the specification minimum in the production area.
10. Compact the production area to at least 98% of the test section maximum.

There are statements throughout the specifications that require a minimum number of passes. Experience has shown that these minimum passes for the different materials result in more uniform compaction in the production areas.

If the specification calls for 8 passes, use the 8 passes even though the test section may show that 6 passes are needed to obtain a maximum. More production area tests will pass by using these minimum passes.

There are also statements throughout the specifications that allow a decrease in minimum number of passes such as:

> *"The Engineer may reduce the minimum passes if the passes are detrimental to compaction".*

There are also statements about making a new test section when conditions change.

> *"Construct a new test section if the pipe type, bedding material, backfill material, or trench conditions change."*

All of these statements allow the Engineer to control the work to meet the field conditions and to obtain maximum densities.

Test Section Value Examples ('X' denotes Maximum Used)

Passes	2	3	4	5	6	Verification Passes (2)
Density	126	134	135	140X	122	125
	110	108	112	116	116X	109
	120	129	132	130		145 (Take more Tests)

Test Section Method B (1015.06)

This type of test section is used when a moisture-density curve cannot be made or is not available at the time of construction. Recycled materials such as some foundry sands or fly ash can be tested this way. Since the maximum density or optimum moisture are unknown, we have to create the field curve.

Use the same procedure as in Section 1015.05 except for the following.

1. Place the material in the required lifts.
    a. Bone dry (0 to 3%).
2. Compact and test until:
    a. A maximum value is reached.
    b. Record the density on Line 6 on the *CA-EW-5*.

    c. Record the number of passes on line 9.
3. Place new material.
    a. At a new location.
    b. At a moisture content 2% higher.
4. Compact and test to a maximum value.
5. Repeat the procedure.
    a. At higher moisture until.
        i. Maximum value is achieved.
        ii. Two test sections have the same or lower densities.
        iii. Material becomes unstable.
6. Use this maximum density, optimum moisture and number of passes in the production areas.

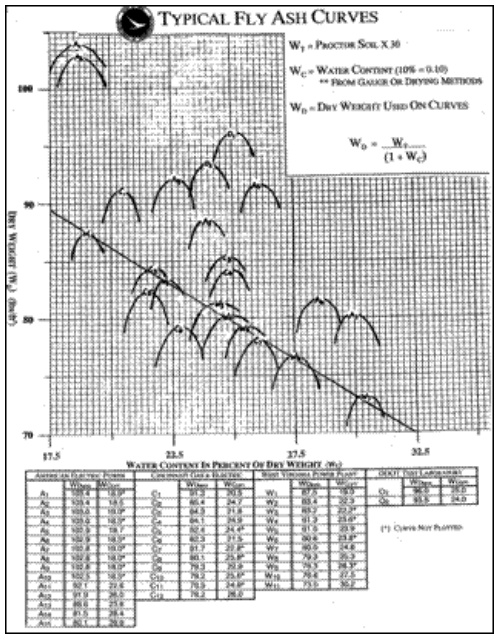


Figure 1015.06.A - Typical Fly Ash Curves

Test Section Method C (1015.07)

This test section is used for open graded material such as non-stabilized drainage base. It also can be used for open graded aggregate bases where the surface texture is very open and or non-uniform.

The test section procedure is the same as detailed in 1015.05 except for the following:

1. Use the *CA-EW-7* compaction form.
2. Place the material at 3% above saturated surface dry (SSD).
3. Compact at 1.5% above SSD.
4. Construct a Test Section.
    a. 400 square yards.
    b. Take 3 tests.
    c. Then average them.
    d. Compare the averages.
    e. See Section 2 of the *CA-EW-7* Form.
5. The maximum is reached when:
    a. A maximum density average is achieved.

b. Or the aggregate breaks.
c. Whichever is first.

6. Take 10 tests in the control section.
   a. See Section 3 on the *CA-EW-7*.
   b. Use 95% of this density as the control section maximum.
7. For acceptance.
   a. Take 5 tests in a 5000 square yard lot.
   b. This average must be greater than 95% of the control section maximum.

Compaction Testing for Shale (1015.08)

Compaction testing for shale will depend on the durability of the shale. Perform the durability test ("bucket test") outlined in Section *203.02.P* under Shale Identification (*703.16.D*). The compaction testing is directly associated with the results. It provides a ready means to determine what test method to use for compaction acceptance. The following is a summary:

1. If less than 25% of the shale is retained on the ¾ inch (19 mm) sieve.
   a. Then test and break down like soil.
   b. Use the one-point proctor method.
2. If 25 to 75% of the shale is retained on the ¾ inch (19 mm) sieve.
   a. Break down to granular material size.
   b. Test for compaction test using the test section method.
3. When greater than 75% of the shale is retained on ¾ inch (19 mm) sieve, use roller method in *703.16.D.4* for durability.
   a. If more than 40% breaks down.
      i. Break down to granular size.
      ii. Use the test section method.
   b. If less than 40% breaks down.
      i. Hard Durable Shale.
      ii. Use roller passes in *203.06*.
      iii. No testing is required.

In practice, different materials will always be mixed together in a fill situation. However, this hardness or durability test gives a good indication of how the material should break down during compaction, and is an excellent means to determine compaction acceptance.

Compaction Acceptance (1015.09)

This section divides up the work into lots. It allows the project to accept material based on a lot size. The lot size is denoted in section 1015.10.

Minimum Number of Tests (1015.10)

Use Forms *CA-EW-5*, *CA-EW-6* and *CA-EW-7* for recording and reporting results of compaction tests. Retain these tests in the project files. Keep these tests in the folders of the items of work.

This section outlines the lot size and number of tests that are used on each lot for acceptance.

Under normal field conditions, the number of density and moisture checks required should not be great after the initial period of adjustment, assuming that the work is proceeding smoothly and materials being compacted are uniform.

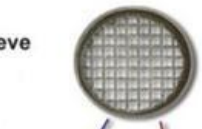
The Engineer and inspector will learn to judge the moisture content of the material quickly by appearance and feel. If adequate densities are being obtained and the proper moisture content is being maintained, the job of inspection may then become one of deciding on the number of passes of the roller required for satisfactory test section density and seeing that this number of passes is actually made.

Under such conditions, only one or two density checks per day may be required. Where conditions are more variable, density and moisture checks may be needed as often as once an hour. The Engineer and Inspector can determine the exact number of checks required.

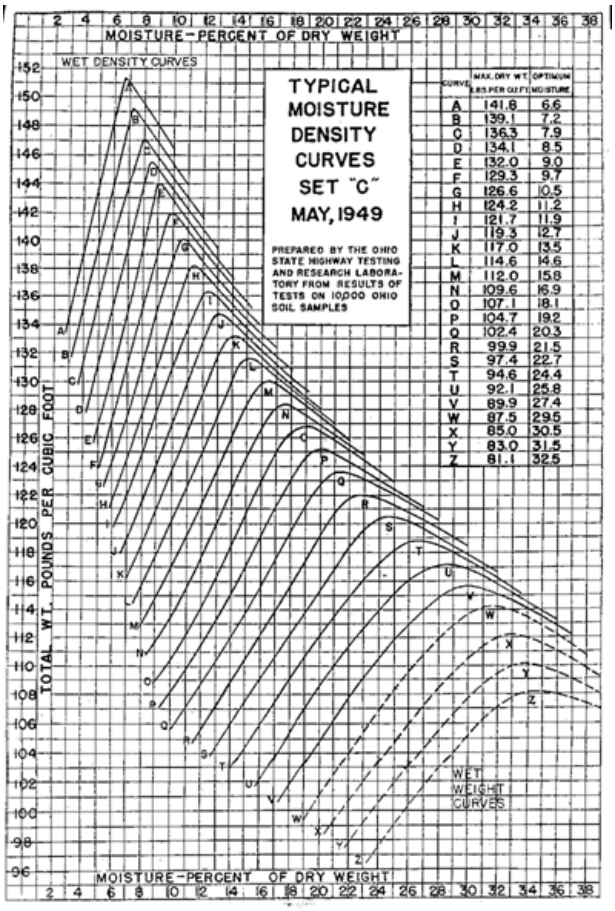
Sample problems for forms CA-EW-5 and CA-EW-6

1	Soil (8" lifts)	Sieve 3/4"	<10% Retained	A. One Point	
	Defined at >35% P-200		>10% Retained	B. Aggregate Correction	
			>25% Retained	C. Granular Material	See Granular
2	Granular Material < 35% P-200	8" Lifts	Moisture Density Curve	Test Section	Method A With Curve
	Examples: 304	Method A			Method B No Curve
	307	Method C			Method C Variable Material
3	Rock	3' Lifts or Largest Particle	18" Lifts near Bridges	Track and Fill Voids	Compact & Use Roller Passes
4	Rock & Shale Mixtures	8" Lifts		Compact like Shale	
5	Shale (8" Lifts)	Bucket Durability Test	< 25 % Retained In 3/4" Sieve	One Point	
			25-75 % Retained	Test Section	
			> 75 % Retained	Roller Passes	
				> 40 % Breaks Down	Test Section
				< 40 % Breaks Down	Roller Passes

Form C-135 Line #	Form C-173 Line #		
4 & 7	1 & 2	Step 1 Standard Count Volume 3 Section 1015.02.D.1 Step 1	
5, 6 & 8	3 - 5	Step 2 In Place Readings Volume 3 Section 1015.02.D.1 Step 2	
		Step 3 Dig Hole Under Gauge Obtain a 10 lb Sample Volume 3 Section 1015.02.F Step A	

Form C-135B Line #	Form C-173 Line #	
	6 - 10	**Step 4** Sieve thru 3/4" Sieve Volume 3 1015.02.F Step B 
	10	**Step 5** Ws/Wt x 100 = Percent Stone  -3/4" Material + 3/4" Material Ws < 10 % Do Nothing > 10% Aggregate Correction C-173 >25 % Test Section Method
10 - 13	11 - 14	**Step 6** Make a Proctor Volume 3 Section 1015.01.B.2 Step D Figure 1015.01.D 
14 - 17	15 -18 & 20-24	**Step 7** Pick a Curve & Calculate Compaction Section 1015.02.F (C-135) Section 1015.03.B.2 (C-173) 

Page 2 of the Compaction Testing Outline



Ohio Typical Density Curves

CA-EW-5
03/03/03

STATE OF OHIO
DEPARTMENT OF TRANSPORTATION
NUCLEAR GAUGE COMPACTION FORM

Sample ID: 1113722540-416 Personnel ID: 111 - 0000 - 111 Date Sampled: 04 / 16 / 00
Type of Inspection: COMPACTION Producer Code: 55555 - 2 Contractor: Dave's Excavating
Material Code: 20340001 Test Results: PASS

Project Number: Item Code: Reference Number:
Notes:

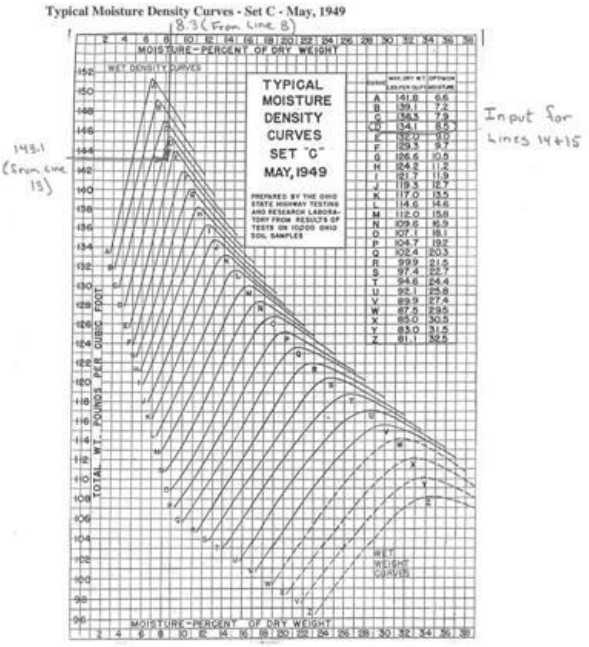
Test of (check which): ☒ Embankment ☐ Subgrade ☐ Base ☐ Other Min. Compaction Req.: 98 %
Test of (check which): ☐ Limestone ☒ Gravel ☐ Slag ☐ Sandstone ☐ Granulated Slag ☐ Other
From Sta 1 + 00 at 5 feet (Rt or lt.) of centerline to Sta 2 + 00 at 10 feet (Rt or lt.) of centerline, at approx. Elevation 970 ft
See Report No. (check which): Wet ☐ Dry ☒ Maximum Density from Test Section lb/ft³ Optimum Moisture %
98% of Max. Density lb/ft³ Check Method used: ☒ Direct Transmission ☐ Backscatter Probe Depth 6 inches

		1.	2.	3.	4.	5.	6.
1. Station of test	1.	109 + 50	129 + 50				
2. Distance (Rt) or left of centerline if different than above (ft)	2.	10	12				
3. Approximate Elevation if different than above (ft)	3.						
Procedure for Determining Dry and Wet Density							
4. Standard Count for Density	4.	2206					
5. Wet Density of soil from gauge (lb/ft³)	5.	130.9	144.4				
6. Dry Density of soil from gauge (lb/ft³)	6.	130.1	133.0				
Procedure for Determining Moisture Content							
7. Standard Count for moisture	7.	3599					
8. Moisture content of soil from gauge * (%)	8.	7.5	(8.3)				
9. Number of Passes	9.	8	10				
Take sample (about 10 lb) of material from area tested for density. Procedure when sample contains less than 10 % total weight in stone retained on 3/4" sieve**		Curve D	Curve D	Curve____	Curve____	Curve____	Curve____
10. Weight of 1/30 ft³ compacted wet soil + weight of container (lb)	10.	13.95	14.01				
11. Weight of 1/30 ft³ container (lb)	11.	9.24	9.24				
12. Weight of 1/30 ft³ compacted wet soil (#10 - #11) (lb)	12.	4.71	4.77				
13. Density of compacted wet soil (30 x #12) (lb/ft³)	13.	141.3	(143.1)				
14. Optimum moisture from dry density curve, Curve No. (D) (%)	14.	8.5	8.5				
15. Maximum Dry Density _Curve No. (D) (lb/ft³)	15.	134.1	134.1				
16. Amount above ☐ or below ☐ optimum moisture (#14 - #8) (%)	16.	+ 1.0	- 0.2				
17. Compaction [(#6 ÷ #15) x 100] (%)	17.	97.0	99.2				
18. Moisture from the zero air voids curve using line 6	18	10.5	9.5	9.5 x 8.3 ✓	OK		
19. Does material tested meet Specification requirements? Yes ☐ No ☐	19.	NO	YES				
20. "A" Rolling ordered; "B" Aerating ordered; "C" Watering ordered	20.	A					
21. Date Tested	21.	08 / 22 / 92	08 / 22 / 92				

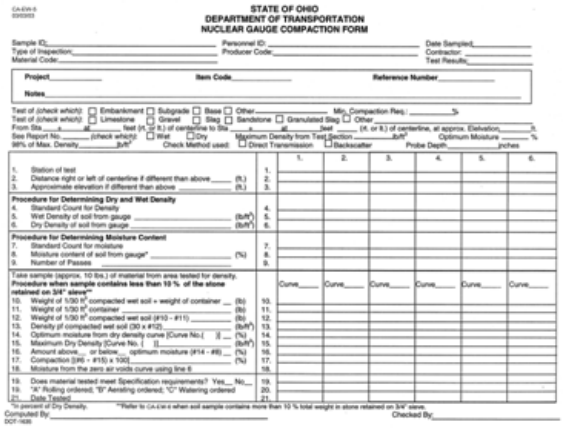
* In percent of Dry Density. ** Refer to C-173 when sample contains more than 10 % total weight in stone retained on 3/4" sieve;

Computed By: SCOTT COMPACTION Checked By DIRECTOR GALLAGHER
DOT-1635

Filled Out CA-EW-5



Ohio Typical Density Curves for the CA-EW-5 Example



STATE OF OHIO
DEPARTMENT OF TRANSPORTATION
NUCLEAR GAUGE COMPACTION FORM

Sample ID:_____ Personnel ID:_____ Date Sampled:_____
Type of Inspection:_____ Producer Code:_____ Contractor: _____
Material Code:_____ Test Results:_____

Project_____ Item Code_____ Reference Number_____

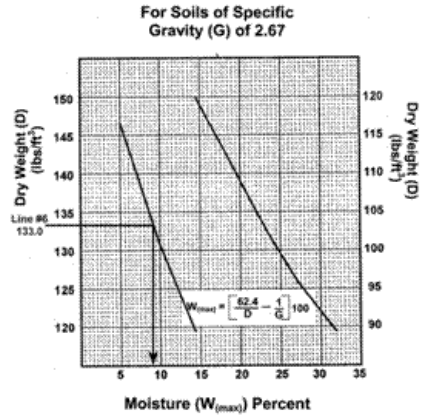
Notes_____

Test of (check which): ☐ Embankment ☐ Subgrade ☐ Base ☐ Other_____ Min. Compaction Req.: _____%
Test of (check which): ☐ Limestone ☐ Gravel ☐ Slag ☐ Sandstone ☐ Granulated Slag ☐ Other_____
From Sta._____+_____ at_____ feet (rt. or lt.) of centerline to Sta._____+_____ at_____ feet_____ (rt. or lt.) of centerline, at approx. Elevation_____ ft.
See Report No._____ (check which): ☐ Wet ☐Dry Maximum Density from Test Section_____ lb/ft³ Optimum Moisture _____ %
98% of Max. Density_____ lb/ft³ Check Method used: ☐ Direct Transmission ☐ Backscatter Probe Depth_____ inches

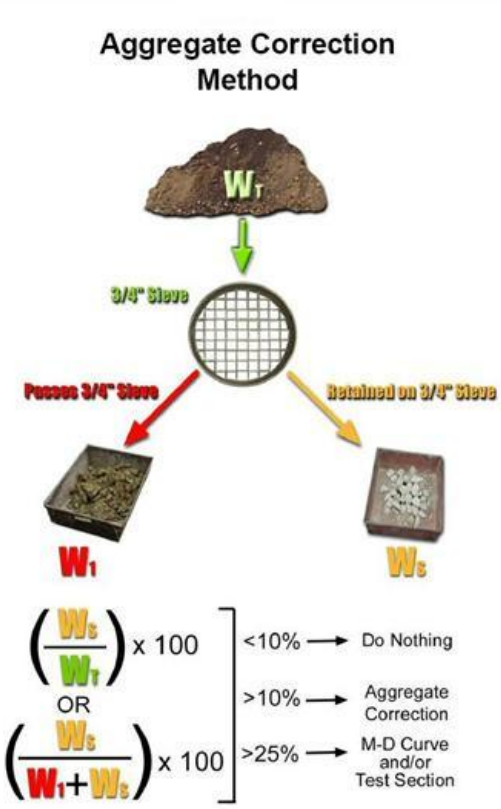
		1.	2.	3.	4.	5.	6.
1. Station of test	1.						
2. Distance right or left of centerline if different than above _____ (ft.)	2.						
3. Approximate elevation if different than above _____ (ft.)	3.						
Procedure for Determining Dry and Wet Density							
4. Standard Count for Density	4.						
5. Wet Density of soil from gauge _____ (lb/ft³)	5.						
6. Dry Density of soil from gauge _____ (lb/ft³)	6.						
Procedure for Determining Moisture Content							
7. Standard Count for moisture	7.						
8. Moisture content of soil from gauge* _____ (%)	8.						
9. Number of Passes _____	9.						
Take sample (approx. 10 lbs.) of material from area tested for density.		Curve____	Curve____	Curve____	Curve____	Curve____	Curve____
Procedure when sample contains less than 10 % of the stone retained on 3/4" sieve**							
10. Weight of 1/30 ft³ compacted wet soil + weight of container __ (lb)	10.						
11. Weight of 1/30 ft³ container _____ (lb)	11.						
12. Weight of 1/30 ft³ compacted wet soil (#10 - #11) _____ (lb)	12.						
13. Density pf compacted wet soil (30 x #12) _____ (lb/ft³)	13.						
14. Optimum moisture from dry density curve [Curve No.( )] __ (%)	14.						
15. Maximum Dry Density [Curve No. ( )] _____ (lb/ft³)	15.						
16. Amount above__ or below__ optimum moisture (#14 - #8) __ (%)	16.						
17. Compaction [(#9 ÷ #15) x 100] _____ (%)	17.						
18. Moisture from the zero air voids curve using line 6	18.						
19. Does material tested meet Specification requirements? Yes__ No__	19.						
19. "A" Rolling ordered; "B" Aerating ordered; "C" Watering ordered	20.						
21. Date Tested	21.						

*In percent of Dry Density. **Refer to CA-EW-6 when soil sample contains more than 10 % total weight in stone retained on 3/4" sieve.
Computed By:_____ Checked By:_____
DOT-1626

Blank CA-EW-5



Zero Air Voids Curve for the CA-EW-5 Example



Aggregate Correction Method

CA-EW-6
03/03/03

STATE OF OHIO
DEPARTMENT OF TRANSPORTATION
NUCLEAR GAUGE COMPACTION WITH AN AGGREGATE CORRECTION

Sample ID: [ ] Date Sampled: _____
Type of Inspection: _____ Producer Code: _____ Contractor: _____
Material Code: _____ Test Results: _____

Project Number _____ Item Code _____ Ref. Number _____

Notes _____

Test of *(check which)*: ☐ Embankment ☐ Subgrade ☐ Base ☐ Other _____ Min. Compaction Req.: _____ %
From Sta _____ + _____ at _____ feet _____ (rt. or lt.) of centerline, at approx. Elevation _____ ft.



I. Nuclear Gauge Readings

1.	Standard Count for Density	1.=	2206
2.	Standard Count for Moisture	2.=	3599
3.	Wet Density of the Soil from the Gauge	3.=	129.1 lb/ft³
4.	Dry Density of the Soil from the Gauge	4.=	111.1 lb/ft³
5.	Percent Moisture from the Gauge	5.=	16.2 %

II. Remove the Soil from Under the Gauge and Sieve the Soil Through a 3/4" Sieve

6.	Weight of wet soil (& stone if any) from hole + weight of pan	6.=	14.0 lb
7.	Weight of Pan or Container	7.=	2.0 lb
8.	Weight of wet soil (& stone if any) from under the nuclear gauge (#6 less #7)	8.=	12.0 lb
9.	Weight of stone & Sieve or Pan	9.=	3.4 lb
9a.	Weight of Sieve or Pan	9a.=	1.0 lb
9b.	Weight of stone removed from sample and retained on 3/4" Sieve (#9 less 9a)	9b.=	2.4 lb
10.	Percent stone in sample (9b ÷ #8 x 100)	10.=	20.0 %

III. Proctor Test Using the Soil Passing the 3/4" Sieve

11.	Weight of 1/30 ft³ compacted wet soil + weight of container	11.=	13.40 lb
12.	Weight of 1/30 ft³ container	12.=	9.24 lb
13.	Weight of 1/30 ft³ compacted wet soil (#11 less #12)	13.=	4.16 lb
14.	Density of compacted wet soil (30 x #13)	14.=	124.8 lb/ft³

IV. Pick the Correct Curve from the Ohio Typical Density Curves Using #14 and (#5 or #16)

15.	Optimum moisture from Dry Weight Curve (Curve N)	15.=	16.9 %
16.	Moisture from Line 5 or Corrected moisture by Drying if required	16.=	16.2 %
17.	Amount above ☐ or below ☒ optimum moisture (#16 - #15)	17.=	-0.7 %
18.	Maximum Dry Density (From Curve No. N)	18.=	109.6 lb/ft³

V. Compaction Calculation Procedure When Line 10 is less than 10%

19.	Compaction (#4 ÷ #18 x 100)	19.=	line 10 > 10% → Go to line 20

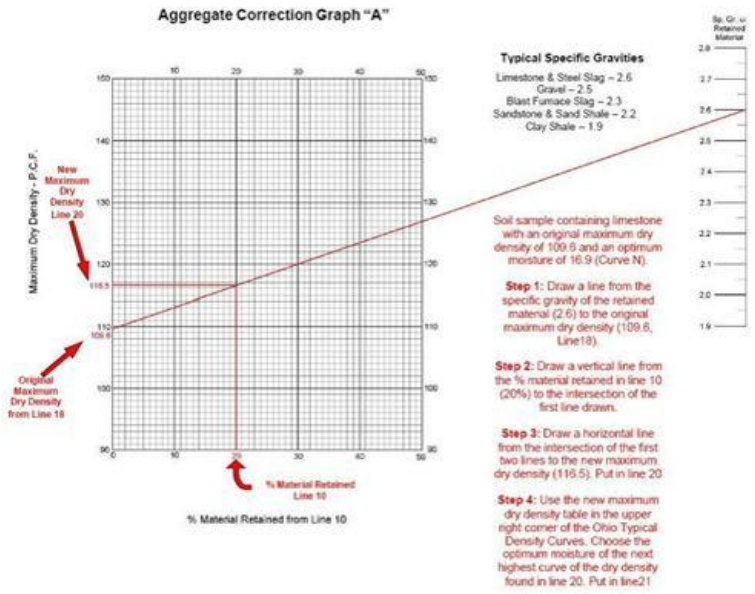
VI. Compaction Calculation When Line 10 is greater than 10% and less than 25%**

20.	Corrected Maximum Dry Density using Graph A and Lines (#10 & 18)	20.=	116.5 lb → Use Graph "A"
21.	Corrected Optimum Moisture using line 20 and Typical Density Curves	21.=	13.5 %
22.	Compaction (#4 ÷ #20 x 100)	22.=	95.4 %
23.	Amount above ☒ or below ☐ optimum moisture (#5 - #21)	23.=	+ 2.7 %
24.	Moisture from zero air voids curve using (#4)	24.=	18.0 % > 16.2 O.K.

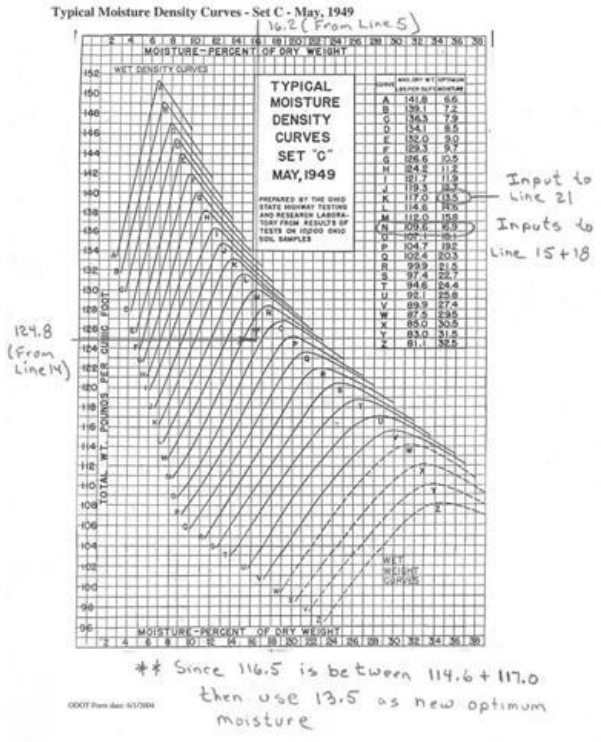
*Average Specific Gravity Values: Limestone = 2.6; Gravel = 2.5; Sandstone & Sandy Shale = 2.2
**If line 10 is greater than 25%, make a Gradation Moisture Density Curve and use the Test Section Method.

Does material tested meet specification requirements for: (write YES or NO on each of the following)
Max. dry weight: Yes ; Moisture: Yes ; Compaction: No ;
Does test check zero air voids curve *(check which)*: YES X NO
Action taken by *(check which)*: Inspector_____ Project Engineer_____
If material tested does not meet specification requirements:
Additional rolling ordered____ Aerating ordered_____ Watering ordered_____ Other
Computed By:_____ Checked By:_____
DOT-1646

CA-EW-6 Example



Aggregate Correction Graph A



Ohio Typical Density Curve for CA-EW-5 Example

CA-EW-6
03/03/03

STATE OF OHIO
DEPARTMENT OF TRANSPORTATION
NUCLEAR GAUGE COMPACTION WITH AN AGGREGATE CORRECTION

Sample ID: [ ] **Date Sampled:** _____
Type of Inspection: _____ **Producer Code:** _____ **Contractor:** _____
Material Code: _____ **Test Results:** _____

Project Number _____ **Item Code** _____ **Reference Number** _____

Notes _____

Test of *(check which)*: ☐ Embankment ☐ Subgrade ☐ Base ☐ Other _____ Min. Compaction Req.: _____%
From Sta _____ + _____ at _____ feet _____ (rt. or lt.) of centerline, at approx. Elevation _____ ft.

I. Nuclear Gauge Readings			
1. Standard Count for Density	1.= _____	1.= _____	
2. Standard Count for Moisture	2.= _____	2.= _____	
3. Wet Density of the Soil from the Gauge	3.= _____ lb/ft³	3.= _____ lb/ft³	
4. Dry Density of the Soil from the Gauge	4.= _____ lb/ft³	4.= _____ lb/ft³	
5. Percent Moisture from the Gauge	5.= _____ %	5.= _____ %	
II. Remove the Soil from Under the Gauge and Sieve the Soil Through a 3/4" Sieve			
6. Weight of wet soil (& stone if any) from hole + weight of pan	6.= _____ lb	6.= _____ lb	
7. Weight of Pan or Container	7.= _____ lb	7.= _____ lb	
8. Weight of wet soil (& stone if any) from under the nuclear gauge (#6 less #7)	8.= _____ lb	8.= _____ lb	
9. Weight of stone & Sieve or Pan	9.= _____ lb	9.= _____ lb	
9a. Weight of Sieve or Pan	9a.= _____ lb	9a.= _____ lb	
9b. Weight of stone removed from sample and retained on 3/4" Sieve (#9 less 9a)	9b.= _____ lb	9b.= _____ lb	
10. Percent stone in sample (9b ÷ #8 x 100)	10.= _____ %	10.= _____ %	
III. Proctor Test Using the Soil Passing the 3/4" Sieve			
11. Weight of 1/30 ft³ compacted wet soil + weight of container	11.= _____ lb	11.= _____ lb	
12. Weight of 1/30 ft³ container	12.= _____ lb	12.= _____ lb	
13. Weight of 1/30 ft³ compacted wet soil (#11 less #12)	13.= _____ lb	13.= _____ lb	
14. Density of compacted wet soil (30 x #13)	14.= _____ lb/ft³	14.= _____ lb/ft³	
IV. Pick the Correct Curve from the Ohio Typical Density Curves Using #14 and (#5 or #16)			
15. Optimum moisture from Dry Weight Curve (Curve__)	15.= _____ %	15.= _____ %	
16. Moisture from Line 5 or Corrected moisture by Drying if required	16.= _____ %	16.= _____ %	
17. Amount above ☐ or below ☐ optimum moisture (#16 - #15)	17.= _____ %	17.= _____ %	
18. Maximum Dry Density (From Curve No. __)	18.= _____ lb/ft³	18.= _____ lb/ft³	
V. Compaction Calculation Procedure When Line 10 is less than 10%			
19. Compaction (#4 ÷ #18 x 100)	19.= _____ %	19.= _____ %	
VI. Compaction Calculation When Line 10 is greater than 10% and less than 25%**			
20. Corrected Maximum Dry Density using Graph A and Lines (#10 & 18)	20.= _____ lb/ft³	20.= _____ lb/ft³	
21. Corrected Optimum Moisture using line 20 and Typical Density Curves	21.= _____ %	21.= _____ %	
22. Compaction (#4 ÷ #20 x 100)	22.= _____ %	22.= _____ %	
23. Amount above ☐ or below ☐ optimum moisture (#5 - #21)	23.= _____ %	23.= _____ %	
24. Moisture from zero air voids curve using (#4)	24.= _____ %	24.= _____ %	

*Average Specific Gravity Values: Limestone = 2.6; Gravel = 2.5; Sandstone & Sandy Shale = 2.2
**If line 10 is greater than 25%, make a Granular Moisture Density Curve and use the Test Section Method.

Does material tested meet specification requirements for: (write YES or NO on each of the following)
Max. dry weight:_____ ; Moisture:_____ ; Compaction:_____ ;
Does test check zero air voids curve *(check which)*: YES_____ NO_____
Action taken by *(check which)*: Inspector_____ Project Engineer_____
If material tested does not meet specification requirements:
Additional rolling ordered_____ Aerating ordered____ Watering ordered_____ Other_____
Computed By:_____ Checked By:_____
DOT-1646

Blank CA-EW-6

Documentation Requirements - Supplement 1015 Compaction Testing of Unbound Materials

1. Document all materials, inspection and compaction information on Form *CA-EW-12*.
2. For Items 203, 204, 205, 206, 840, 503, 603 Soil Embankment and all Items where 203 Embankment is specified
    a. If less than 10 percent of material passes the ¾ inch sieve, document on form *CA-EW-5*
    b. If more than 10 percent but less than 25 percent of the material passes the ¾ inch sieve, document on form *CA-EW-6*
    c. If more than 25 percent of the material passes the ¾ inch sieve, document on form *CA-EW-5*
3. Items 203 Granular Embankment, 203 Granular Material Types A, B, C, D or F, Item 304, 411, 503, Select Granular Backfill for MSE walls and 603 Structural Backfill and Granular Embankment, document on form *CA-EW-5*
4. Non-stabilized drainage base, Document on *CA-EW-7*

APPENDIX D

OHIO DEPARTMENT OF DEVELOPMENT BROWNFIELD REMEDIATION PROGRAM GRANT AGREEMENT

Ohio Department of Development
Brownfield Remediation Program
Grant Agreement

This Grant Agreement (the "Agreement") is made and entered into between the Ohio Department of Development (the "Grantor") "), located at 77 South High Street, Columbus, Ohio 43215 and **Port Authority of Allen County** (the "Grantee") for the period **January 1, 2022** to **June 30, 2023** set forth the terms and conditions upon which Grantor will provide financial assistance to Grantee and Grantee will use the financial assistance for costs of implementing the Brownfield Remediation Program in accordance with the terms of this Agreement, the Grant Application (the "Application"), which consists of the collective materials submitted by Grantee to Grantor via Grantor's online system, the contents of this Agreement (collectively, the "Project") and the Brownfield Remediation Program Guidelines. In the event there is a conflict between this Agreement and the Exhibits, the Exhibits control.

Statement of the Agreement

1. **Award of Grant Funds**. Grantor hereby grants funds to Grantee in the amount of **$710,000.00** (the "Grant Funds"), for the sole and express purpose of providing for the performance of the program listed above and undertaking the Project(s) as listed in **Application** which is incorporated herein by reference. Grantee may not use the Grant Funds for any purpose other than completion of the Project. The Grant Funds shall be further contingent upon the Special Conditions set forth in Exhibit IV: Special Conditions, if applicable. Expenditures shall be supported by contracts, invoices, vouchers and other data as appropriate, including the reports listed in accordance with the schedule set forth in **Exhibit II: Reporting**, evidencing the costs incurred. If the Grant Funds are not expended in accordance with the terms, conditions and time period set forth in this Agreement or the total amount of the Grant Funds exceeds the eligible costs of the Project(s), the amounts improperly expended or not expended shall be returned to Grantor within 30 days after the expiration or termination of this Agreement. Grantee shall not pledge the Grant Funds as security for any loan or debt of any kind other than that described in this Agreement.

2. **Funding Source**. The Brownfield Remediation Program was established in House Bill 110 of the 134th General Assembly, codified in Ohio Revised Code section 122.6511 and found in the Ohio Administrative Code sections 122:31-1-01 through 122:31-1-06. This program awards grants for the assessment or remediation of brownfield sites throughout Ohio.

3. **Term of Agreement**. This Agreement shall be effective from the Beginning Date and shall continue through the Expiration Date set forth on page one of this Agreement, unless terminated earlier in accordance with Section 15 of this Agreement. Reporting and refund obligations shall continue in accordance with the schedules set forth in Exhibit II and until satisfactorily completed.

4. **Scope of Work.** Grantee shall undertake the Project(s) as listed in the Application. Grantor may, from time to time, as it deems appropriate and necessary, communicate specific instructions and requests and provide guidance and direction to Grantee concerning the performance of the work described in this Agreement. Within a reasonable period of time, Grantee shall comply with such instructions and fulfill such requests to the satisfaction of Grantor. These instructions and requests are to ensure the satisfactory completion of the work contemplated under this Agreement. In no event shall the Grant Funds be used for any other purpose than that described in this Agreement.

5. **Payment of Grant Funds.** Payment to Grantee of the Grant Funds shall be made upon the timely submission to Grantor of a financial reimbursement request. Grantee shall deposit all Grant Funds received under this Agreement in a Federal Deposit Insurance Corporation (FDIC) account and record in a separate account on the books of Grantee. Grantor reserves the right to suspend payments should Grantee fail to provide required reports in a timely and adequate fashion or if Grantee fails to meet other terms and conditions of this Agreement. Grantor may withhold payment requests if Grantee fails to comply with the above requirements until such compliance is demonstrated. If applicable, Grantor with not release the final 10% of funding until Grantee confirms matching funds are expended.

6. **Reporting Requirements.** Grantee shall submit to Grantor the reports required in **Exhibit II: Reporting**.

7. **Records, Access and Maintenance.** Grantee shall establish, and physically control for at least five years from the final close out of this Agreement such records as are required by Grantor, including but not limited to, financial reports, intake and participant information, program and audit reports. The parties further agree that records required by Grantor with respect to any questioned costs, audit disallowances, litigation or dispute between Grantor and Grantee shall be maintained for the time needed for the resolution of any such issue. If for any reason Grantor shall require a review of the records related to the Project(s), Grantee shall, at its own cost and expense, segregate all such records related to the Project(s) from its other records of operation.

8. **Audits.** Grantees receiving a state-funded grant award of less than $500,000 do not have an audit requirement. Grantor may, at its option, choose to send department auditors to complete an audit of any state-funded grant award. Grantees receiving a state-funded grant award equal to or greater than $500,000 are required to submit either a single audit or a grant specific audit report to Ohio Department of Development, Audit Office, P.O. Box 1001, Columbus, Ohio 43216-1001.

   i. Single Audit: Grantee obtains an organization-wide audit. The report includes organization-wide financial statements, an opinion on the financial statements, a report on internal controls, and a report on compliance with the terms and conditions of the grant agreements. The audit report must include a schedule of federal grants. This report should include the division name, the grant name and number, the amount of cash received, the expenditures charged and the balance at the end of the audit period. The audit report must include a report on compliance with the terms and conditions of federal grants. Single audits must be performed by an independent public accountant. Single audits must be submitted to Grantor within 30 days of the date of the release, but no later than nine months after the end of the audit period.

   ii. Grant Specific Audit: Grantee obtains an audit of a specific grant that is equal to or greater than $500,000. The audit report must include a statement of revenues and expenditures for the grant, an opinion on the statements of revenues and expenditures, a report on internal controls as they relate to the grant, and a report on compliance with the terms and conditions of the grant agreement. A grant specific audit must be performed by an independent public accountant. Grant specific audits must be submitted to Grantor within 30 days of the date of the release, but no later than nine months after the end of the grant period.

   iii. Audit Standards: Audits performed by independent public accountants must be performed in accordance with generally accepted auditing standards or generally accepted government auditing standards for financial and compliance audits, whichever is applicable.

9. **Monitoring, Evaluation and Audit Activities**. Grantor shall supervise, evaluate, and provide guidance and direction to Grantee in the conduct of the work and activities to be performed under the terms of this Agreement. Grantee's staff and all parties involved with the project shall cooperate with Grantor and its authorized representatives in their program monitoring and shall maintain and make available to Grantor all programmatic, fiscal, and performance records necessary for Grantor's monitoring and evaluation. Grantee shall submit to Grantor reports detailing the expenditures of the Grant Funds and such other reports as may be required by Grantor, including the reports listed and according to the schedule set forth in **Exhibit II: Reporting**.

10. **Reports and Records.**

   a. Performance Reports. Grantor shall supervise, evaluate and provide guidance and direction to Grantee in the conduct of the work and activities to be performed under the terms of this Agreement.

   b. Signature and Costs. The authorized representative on behalf of Grantee shall certify by his or her submission of each report required by Exhibit II that the information reported by Grantee is true, complete and correct.

11. **Rights of Inspection.** Grantee shall permit Grantor to inspect and copy, during normal business hours, any books and records necessary to ensure compliance with the terms and conditions of this Agreement. Grantee acknowledges and agrees that rights of inspection (1) extend to representatives and agents of Grantor and federal agencies that pass funds through Grantor including, but not limited to, the Auditor of State of Ohio, an appropriate inspector general appointed under applicable federal or state law, the Comptroller General of the United States and/or the Government Accountability Office; (2) include the rights to examine Grantee's corporate accounts or other accounts and/or funding sources within the control and/or name of Grantee when there is evidence (e.g., vouchers, invoices, canceled checks, descriptions, etc.) that these books contain original or substantial source documentation of the federal funds granted herein; (3) contain Grantee's covenant to make all fiscal records available to authorized audit personnel of Grantor and its federal agencies for inspection at any time and as often as Grantor may deem necessary and in a manner as not to interfere with the normal business operation of Grantee; and (4) include Grantee's undertaking to make available to Grantor for interview any officer or employee of Grantee or of any contractor or subcontractor of Grantee regarding the Grant Funds and any transaction involving the Grant Funds. Grantee shall also require each of its non-profit partners, contractors and subcontractors paid with Grant Funds to make its respective books and records available for inspection and copying in the same manner as described in this section for Grantee's books and records.

12. **Budget Alterations.** Grantee may make alterations to any line in its budget submitted with this Agreement as referenced in the **Application** so long as Grantee notifies Grantor of such budget alteration within the electronic application system 30 days prior to the date of the change and Grantor approves the proposed alteration within the electronic application system. Alterations to line items in Grantee's budget shall not increase the amount of Grant Funds awarded under this Agreement. Grantor shall respond to Grantee's request to approve a budget alteration within a reasonable period of time.

13. **Grantee Certifications and Assurances.** By signing this Agreement, Grantee certifies and assures the following:

    a. **Equal Employment Opportunity.** Grantee shall not discriminate against any employee or applicant for employment because of race, religion, color, sex, national origin, disability, age, military status or ancestry. Grantee shall ensure that applicants for employment are considered for employment, and that employees are treated during employment, without regard to their race, religion, color, sex, national origin, disability, age, military status or ancestry. Grantee will incorporate the requirements of this paragraph in all of its contracts for any of the work undertaken on the Project (other than subcontracts for standard commercial supplies or raw materials), and Grantee will require all of its contractors for any part of such work to incorporate such requirements in all subcontracts for such work.

    b. **Property and Equipment Purchases.** All items purchased by Grantee are and shall remain the property of Grantee, except if Grantor exercises its right to terminate this Agreement pursuant to paragraph 14, in which case all property and equipment purchased by Grantee with any Grant Funds herein awarded shall revert to Grantor. Grantee shall provide for the security and safekeeping of all items obtained through this Agreement.

    c. **Accounting systems** used by Grantee are in accordance with generally accepted accounting standards and other applicable local, state and federal statutes, regulations, policies, directives, and guidelines. Grantee has established procedures to ensure good fiscal and management practices to deposit and account for the Grant Funds. Grantee shall make appropriate documentation relating to the Grant Funds available to the Grantor and the U.S. Department of Treasury, the Comptroller General of the United States, or any of their duly authorized representatives, for examination or copying, upon a reasonable request.

    d. Grantee is and shall remain throughout the term of this Agreement insured by a surety or fidelity insurance to cover all individuals responsible for the security and control of the Grant Funds covered under this Agreement. Grantee must file with Grantor a Certification of Fidelity Bonding and Collateral Security of Deposits.

e. **Minority Hiring Goal** Grantee shall make a good faith effort to employ minority persons in the completion and operation of the Project in the same percentage as the average percentage of minority persons who reside in the county in which the Project is located and any contiguous Ohio counties.

14. Termination

a. Grantor may immediately terminate this Agreement by giving reasonable written notice of termination to Grantee for any of the following occurrences:

i. Failure of Grantee to fulfill in a timely and proper manner any of its obligations under this Agreement.
ii. Failure of Grantee to submit any report required by this Agreement that is complete and accurate.
iii. Failure of Grantee to use the Grant Funds for the stated purposes in this Agreement.
iv. Failure to spend matching funds, if applicable.

b. Early Termination: Grantor may also terminate this Agreement if Grantee (i) defaults under another Agreement between the Grantor and/or the Tax Credit Authority and Grantee (ii) admits Grantee's inability to pay its debts as such debts become due, (iii) Grantee commences a voluntary bankruptcy, (iv) an involuntary bankruptcy action occurs against Grantee which remains undismissed or unstayed for 60 days, (v) Grantee fails to meet the minimum funding requirements under the Employee Retirement Income Security Act or other such employee benefits plan, or (vi) Grantor has reason to believe Grantee has ceased operations at the Project location. The events permitting early termination by Grantor shall be considered a default by Grantee and subject to the Effects of Termination under Section 18 of this Agreement.

15. Remedies. Following a default by Grantee, Grantor may exercise one or more of the following remedies:

a. **Discontinue Disbursements**. If the Grant Funds have not been fully disbursed, Grantor may terminate any and all of Grantor's obligations under this Agreement, including the obligation to make further disbursements of Grant Funds.

b. **Suspension or Termination.** Grantor may withhold payment under this Agreement, suspend or terminate the Agreement in whole or in part for cause, which shall include, but is not limited to: (1) failure for any reason by Grantee to fulfill in a timely and proper manner its obligations under this Agreement, or other agreements entered into between the parties, including compliance with the approved program and any and all statutes, Executive Orders, regulations, directives, guidelines, plans or other requirements as may become generally applicable at any time; (2) Grantor determines that the nature or extent of noncompliance is extreme and warrants immediate termination of this Agreement; (3) Grantee ceases to exist or becomes legally incapable of performing its responsibilities under the Agreement; (4) Grantee has failed to comply with any timelines for the expenditure of Grant Funds as required by Grantor; (5) ineffective or improper use of the Grant Funds provided under this Agreement; (6) failure to comply with reporting requirements including, but not limited to, submission by Grantee to Grantor of reports that are incorrect or incomplete in any material respect; (7) suspension or termination of any funds provided under this Agreement, or the portion thereof delegated by this Agreement; and (8) cancellation of grant funds.
Grantee acknowledges that timely performance and attainment of performance measurements are material to Grantee's compliance with this Agreement and a priority of the federal and state governments in the administration of the Grant Funds.

c. **Demand Repayment of Grant Funds.** Under the circumstances described in Section 5 of this Agreement, demand repayment of Grant Funds improperly expended. Grantee shall not be required to refund Grant Funds in an amount that exceeds the Grant Funds awarded.

d. **Other Legal Remedies.** Pursue any other legal or equitable remedies Grantor may have under this Agreement or applicable law.

e. **Remedies Cumulative.** No remedy provided to Grantor under this Agreement or otherwise by law or in equity is exclusive of any other available remedy. No delay or omission by Grantor in exercising any right or power accruing upon any default shall impair any such right or power or be construed as a waiver, and each such right or power may be exercised from time to time as often as may be deemed by Grantor to be expedient.

16. **Effects of Termination.** Within 60 days after termination of this Agreement, Grantee shall surrender all reports, documents, and other materials assembled and prepared pursuant to Agreement, which shall become the property of Grantor, unless otherwise directed by Grantor. After receiving written notice of termination, Grantee shall incur no new obligations and shall cancel as many outstanding obligations as possible. Upon compliance with this Section, Grantee shall receive compensation for all activities satisfactorily performed prior to the effective date of termination.

17. **Liability**.

a. Public Agency or Governmental Entity. If Grantee is a public agency or governmental entity, Grantee shall maintain liability and property insurance to cover actionable legal claims for liability or loss which are the result of injury to or death of any person and damage to property (including property of Grantor) caused by the negligent acts or omissions or negligent conduct of Grantee, to the extent permitted by law, in connection with the work and activities of this Agreement. Furthermore, as between the parties to this Agreement, each party agrees to be liable for the negligent acts or negligent omissions by or through itself and its respective employees, agents, and contractors. Each party to this Agreement further agrees to defend itself and pay any judgments and costs arising out of such negligent acts or omissions, and nothing in this Agreement shall impute or transfer any such liability from one party to the other.

18. **Forbearance Not a Waiver.** No act of forbearance or failure to insist on the prompt performance by Grantee of its obligations under this Agreement, either express or implied, shall be construed as a waiver by Grantor of any of its rights hereunder.

19. **Certification of Funds Available**. None of the rights, duties, and obligations described in this Agreement shall be binding upon either party until all statutory provisions of the Ohio Revised Code, including, but not limited to, Section 126.07, have been complied with, and until such time as all necessary funds have actually been made available and forthcoming from the appropriate state and/or federal agencies.

20. **Budget Reductions.** Grantee acknowledges that Grantor is subject to State of Ohio budgetary constraints that could result in the reduction of the amount of Grant Funds provided under this Agreement. Should Grantor's funding levels be reduced, Grantor shall notify Grantee in writing of the extent of any reduction to the Grant Funds and reduce Grantee's commitments in a manner corresponding to the reduction of Grant Funds and such notice shall result in the Agreement being amended without further action by the parties. Grantee hereby irrevocably authorizes Grantor to reduce the amount of Grant Funds provided under this Agreement upon written notice to Grantee provided there is a corresponding reduction in commitments outlined on page 1 of this Agreement

21. **Conflict of Interest.** No personnel of Grantee, contractor of Grantee or personnel of any such contractor, and no public official who exercises any functions or responsibilities in connection with the review or approval of any work completed under this Agreement, shall, prior to the completion of such work, voluntarily or involuntarily acquire any personal interest, direct or indirect, which is incompatible or in conflict with the discharge or fulfillment of his or her functions or responsibilities with respect to the completion of the work contemplated under this Agreement. Grantee shall immediately disclose in writing to Grantor any such person who, prior to or after the execution of this Agreement, acquires any personal interest, voluntarily or involuntarily. Grantee shall cause any such person who, prior to or after the execution of this Agreement, acquires any personal interest, voluntarily or involuntarily, to immediately disclose such interest to Grantor in

writing. Thereafter, such person shall not participate in any action affecting the work under this Agreement unless Grantor determines that, in light of the personal interest disclosed, his or her participation in any such action would not be contrary to the public interest.

22. Adherence to State and Federal Laws, Regulations.

a. **General.** Grantee shall comply with all applicable federal, state, and local laws in the performance of Grantee's obligations under this Agreement, the completion of the Project and the operation of the Project as long as Grantee has any obligation to Grantor under this Agreement. Without limiting the generality of such obligation, Grantee shall pay or cause to be paid all unemployment compensation, insurance premiums, workers' compensation premiums, income tax withholding, social security withhold, and any and all other taxes or payroll deductions required for all employees engaged by Grantee in connection with the Project, and Grantee shall comply with all applicable environmental, zoning, planning and building laws and regulations.

b. **Ethics.** Grantee, by its signature on this document, certifies: (1) it has reviewed and understands the Ohio ethics and conflict of interest laws including, without limitation, **ORC Sections 102.01 et seq., 2921.01, 2921.42, 2921.421, 2921.43, and 3517.13(I) and (J), and (2)** will take no action inconsistent with those laws, as any of them may be amended or supplemented from time to time. Grantee understands that failure to comply with the ethics and conflict of interest laws, is in itself, grounds for termination of this Agreement and the grant of funds made pursuant to this Agreement and may result in the loss of other contracts or grants with the State of Ohio.

23. Outstanding Liabilities. Grantee represents and warrants that it does not owe: (1) any delinquent taxes to the State of Ohio (the "State") or a political subdivision of the State; (2) any amount to the State or a state agency for the administration or enforcement of any environmental laws of the State; and (3) any other amount to the State, a state agency or a political subdivision of the State that are past due, whether or not the amounts owed are being contested in a court of law.

24. Falsification of Information. Grantee represents and warrants that it has made no false statements to Grantor in the process of obtaining this award of the Grant Funds. If Grantee has knowingly made a false statement to Grantor to obtain this award of the Grant Funds, Grantee shall be required to return all the Grant Funds immediately pursuant to **ORC Section 9.66(C)(2)** and shall be ineligible for any future economic development assistance from the State, any state agency or a political subdivision pursuant to **ORC Section 9.66(C)(1)**. Any person who provides a false statement to secure economic development assistance may be guilty of falsification, a misdemeanor of the first degree, pursuant to **ORC 2921.13(F)(1)**, which is punishable by a fine of not more than $1,000 and/or a term of imprisonment of not more than 180 days.

25. Public Records. Grantee acknowledges that this Agreement and other records in the possession or control of Grantor regarding the Project are public records under **ORC 149.43** and are open to public inspection unless a legal exemption applies.

26. Miscellaneous.

a. **Forum and Venue.** Grantee irrevocably submits to the non-exclusive jurisdiction of any federal or state court sitting in Columbus, Ohio, in any action or proceeding arising out of or related to this Agreement, Grantee agrees that all claims in respect of such action or proceeding may be heard and determined in any such court, and Grantee irrevocably waives any objection it may now or hereafter have as to the venue of any such action or proceeding brought in such court or that such court is an inconvenient forum. Nothing in this Agreement shall limit the right of Grantor to bring any action or proceedings against Grantee in the courts of any other jurisdiction. Any actions or proceedings by Grantee against Grantor or the State of Ohio involving, directly or indirectly, any matter in any way arising out of or related to this Agreement shall be brought only in a court in Columbus, Ohio.

b. **Entire Agreement.** This Agreement, including its exhibits and documents incorporated into it by reference, constitutes the entire agreement and understanding of the parties with respect to its subject matter. Any prior written or verbal agreement, understanding or representation between the parties or any of their respective officers, agents, or employees is superseded and no such prior agreement, understanding or representation shall be deemed to affect or modify any of the terms or conditions of this Agreement.

c. **Program Income**. Any funds that were billed to the property owner as part of a nuisance order or other means and subsequently paid by a property owner to Grantee for Project work that was billed/paid by Grantor with Grant Funds, shall be returned to Grantor.

27. **Severability.** Whenever possible, each provision of this Agreement shall be interpreted in such manner as to be effective and valid under applicable law, but if any provision of this Agreement is held to be prohibited by or invalid under applicable law, such provision shall be ineffective only to the extent of such prohibition or invalidity, without invalidating the remainder of such provisions of this Agreement.

28. **Pronouns.** The use of any gender pronoun shall be deemed to include all the other genders, and the use of any singular noun or verb shall be deemed to include the plural, and vice versa, whenever the context so requires.

29. **Headings.** Section headings contained in this Agreement are inserted for convenience only and shall not be deemed to be a part of this Agreement

30. **Counterparts; PDF Accepted.** This Agreement may be executed in any number of counterparts, each of which when so executed shall be deemed to be an original and all of which taken together shall constitute one and the same agreement. Copies of signatures sent by facsimile transmission or provided electronically in portable document format ("PDF") shall be deemed to be originals for purposes of execution and proof of this Agreement.

a. **Notices.** All notices, consents, demands, requests and other communications which may or are required to be given hereunder shall be in writing and shall be deemed duly given if personally delivered or sent by United States mail, registered or certified, return receipt requested, postage prepaid, to the addresses set forth hereunder or to such other address as the other party hereto may designate in written notice transmitted in accordance with this provision.

i. In the case of Grantor, to:

Ohio Department of Development
Office of Energy and Environment
77 South High Street, P.O. Box 1001
Columbus, Ohio 43216-1001
Attn: Deputy Chief

ii. In the case of Grantee, to:

Port Authority of Allen County
144 South Main Street
Lima, Ohio 45801

Signature

Each of the parties has caused this Grant Agreement to be executed by its authorized representatives as of the dates set forth below their respective signatures.

Grantee:

Port Authority of Allen County

Authorized Official

R. BARRY HARDY

Printed Name:

Secretary / Fiscal Officer

Title:

5/12/2022

Date:

Grantor:

State of Ohio, Department of Development

By:

Matthew McClellan

Printed Name:

Assistant Director

Title:

2022-06-08 07:11:29 UTC

Date:

EXHIBIT I

Scope of Work/Budget/Grant Application

Project scope of work and budget is located within Grantor electronic application system (Salesforce).

EXHIBIT II

Reporting

Grantee shall provide the information listed below by the date(s) specified herein or to be determined by Grantor. Grantor shall provide a format to submit the information and shall instruct Grantee in the proper completion of such documents. The reporting and recordkeeping requirements listed herein shall not be construed to limit Grantor from making additional requests or from changing or including additional detail. Failure to submit required reports will result in non-payment of monthly expenditures.

1. **Financial Reimbursement Requests**: all financial reimbursement requests must be submitted electronically to the Grantor on a monthly basis as costs are incurred. Supporting documentation for costs submitted for reimbursement must be uploaded and submitted within the electronic system as part of the request. If an advance of funds is being requested, provide a rational for the advance and anticipated uses. The rational should include supporting documentation for the requested costs.

2. **Program Reports**: Program reports must be submitted on a quarterly basis. Program reports must be submitted by close of business, on the third Friday at the end of each quarter. Program reports must include the following information:

    a. Narrative summary of use of funds during the reporting period.
    b. Update of outcomes projected in Grantee's Application. Examples may include an assessment initiated or completed, remediation work beginning on the site, additional testing completed and/or further development with the proposed end-use.

3. **Final Report**: A final project report must be submitted 15 days after the end of this Agreement.

EXHIBIT III

Special Conditions may be included within this Grant Agreement as agreed upon by Grantee and Grantor.