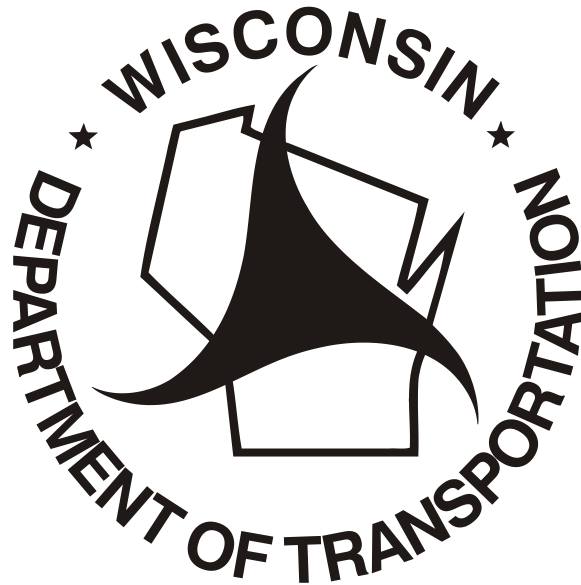


STATE OF WISCONSIN



STANDARD SPECIFICATIONS FOR HIGHWAY AND STRUCTURE CONSTRUCTION

2003 Edition

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PART 1 GENERAL REQUIREMENTS AND COVENANTS

SECTION 101 GENERAL INFORMATION, DEFINITIONS, AND TERMS

101.1 General

- (1) The department defines the contractor and department responsibilities within the contract documents in one of the following ways:
 1. Taken in context, the contract language makes the responsible party clear.
 2. Direct commands written to the contractor in the active voice-imperative mood.
 3. Using "shall" to indicate contractor responsibility and "will" to indicate department responsibility. For example, "Aggregates shall be stored in stockpiles" or "Sampling and testing will be in accordance with the following AASHTO methods..."
- (2) If the contractor thinks the responsibility for an action under the contract is unclear or given to the wrong party, the contractor should seek clarification from the department.
- (3) These standard specifications for highway and structure construction is written to the bidder before award of the contract and to the contractor after award of the contract. The sentences directing the contractor to perform work are written in the active voice-imperative mood. These contractor directions 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.
- (4) All requirements to be performed by others are 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-imperative mood, if the sentence includes requirements for others in addition to the contractor. For example, a sentence that involves action by both the contractor and the engineer would be expressed, "After the contractor provides initial written notice, the engineer will revise the contract as specified in 104.2."
- (5) Sentences that define terms, describe a product or desired result, or describe a condition that may exist are written in neither the active voice nor the imperative mood. These types of sentences that describe a condition use verbs requiring no action. For example, "The characteristics of the soils actually encountered in the subgrade may affect the quality of cement and depth of treatment necessary."
- (6) The document contains the following components identified by number and organized in a hierarchy as follows:
 1. Parts, for example "Earthwork" referred to as: part 2.
 2. Sections, for example "Bidding Requirements and Conditions" referred to as: section 102.
 3. Subsections, potentially containing subordinate subsections, for example "Issuing Bidding Proposals" referred to as: 102.3 or "General" referred to as: 102.3.1.
 4. Paragraphs, for example paragraph one of 102.3.2 referred to as: 102.3.2(1).
 5. Numbered items, for example item one of 102.3.2(1) referred to as: item one of 102.3.2(1).
- (7) In addition to the identifying numbers shown in the document, parts, sections, and subsections have descriptive titles. These titles provide reference only, not interpretation. If a subsection contains a subordinate subsection entitled "General," the provisions of that general subsection apply to all subsections in the parent subsection.
- (8) Bid item names are capitalized, as are all proper names and acronyms. Capitalization of other words not beginning a sentence is avoided.
- (9) This document is dual dimensioned. The primary values are contractually binding while the equivalent values, shown in parentheses, are provided for user information only.

101.2 References and Acronyms

- (1) References made within these specifications use the conventions specified in paragraph 4 of subsection 101.1. For example, 101.1(4) is used to make the reference in the previous sentence. References to parts or sections include the words "part" or "section", references to subsections or paragraphs use only the identifying numbers, and references to numbered items use the words "item number ___ of " and the identifying paragraph number. Occasionally a subsection will contain a reference to itself to avoid possible confusion due to the nesting of subsections. Imprecise references like: "in this subsection," "above," "below," "elsewhere in the contract," etc. are eliminated.

- (2) Unless specified by year or date, cited publications refer to the most recent issue, including interim publications, in effect on the bid closing date.
- (3) The department identifies acronyms used throughout the contract here in 101.2. The department may also identify acronyms, used in a more limited scope, within individual parts of the contract. Interpret acronyms used throughout the contract as follows:

AASHTO	American Association of State Highway and Transportation Officials
ACT	See HTCP
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute, Inc.
ASTM	American Society for Testing and Materials
ATMS	Advanced Traffic Management Systems
AWPA	American Wood Preservers' Association
AWG	American Wire Gauge
AWS	American Welding Society
AWWA	American Water Works Association
CMM	The department's Construction and Materials Manual
EBS	Excavation below subgrade.
ECIP	Erosion Control Implementation Plan
EIA/TIA	Electronic Industry Association/Telecommunications Industry Association
FHWA	Federal Highway Administration
FOA	Fiber Optic Association
FTMS	Freeway Traffic Management System
HTCP	The department's Highway Technician Certification Program
ACT	An HTCP assistant certified technician
IES	Illuminating Engineering Society
IPCEA-NEMA	Insulated Power Cable Engineer's Association - National Electrical Manufacturer's Association
IPS	Iron Pipe Size
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
MIL	Military Specification
MUTCD	The Wisconsin Manual on Uniform Traffic Control Devices for Streets and Highways
NACE	National Association of Corrosion Engineers
NIST	National Institute of Standards and Technology
NCHRP	National Cooperative Highway Research Program
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NTPEP	AASHTO's National Transportation Product Evaluation Program
OSHA	Occupational Safety and Health Administration
QMP	The department's Quality Management Program
CA	Contractor Assurance
QC	Quality Control
QV	Quality Verification
IA	Independent Assurance

SAE	Society of Automotive Engineers
SI	International System of Units
SSPC	Steel Structures Painting Council
UL	Underwriters' Laboratory
USACE	United States Army Corps of Engineers
WDNR	Wisconsin Department of Natural Resources
WEC	Wisconsin Electrical Code
WSEC	Wisconsin State Electrical Code, consisting of chapter comm. 16 of the WEC combined with the NEC

101.3 Definitions

- (1) The department defines terms used throughout the contract here in 101.3. The department may define, or redefine, terms within individual parts of the contract if using those terms in a more limited scope. Interpret these terms, used throughout the contract, as follows:

Addenda	Revisions to the plans or the proposal form developed before opening of proposals.
Adjustment	A modification in the contract price or contract time as specified in 108.10 or 109.4 .
Adverse weather day	For calendar day or completion date contracts, a day the contractor is scheduled to work when weather, or job conditions caused by recent weather, cause the contractor to lose 4 or more hours of work on the controlling item.
Advertisement	See also notice to contractors
Affiliated	Having a relationship where one business concern or individual directly or indirectly controls or can control the others.
Auxiliary lane	The portion of the roadway adjoining the traveled way for parking, change of speed, or for other purposes supplementary to through traffic movement.
Award	The department's acceptance of a bid.
Base	The layer or layers of specified or selected material of designed thickness placed on a subbase or subgrade to support a surface course.
Bid	See proposal
Bidder	An individual, partnership, joint venture, corporation, limited liability company, limited liability partnership, or a combination of any or all jointly, submitting a proposal (bid) for the work advertised in the invitation for bids, acting directly or through a duly authorized representative.
Bidding proposal	The department-approved form the department requires bids to be prepared and submitted for the work on. The bidding proposal is further described in 102.2 .
Bridge	A structure having a span of more than 20 feet from face to face of abutments or end bents, measured along the centerline of the roadway, spanning a water course or other opening or obstruction, such as a highway or railroad, including the substructure, superstructure, and trestle work approaches.
Bureau	The department's bureau of highway construction. Language specifically identifies other department bureaus.
Business day	Every day the calendar shows, excluding Saturdays, Sundays, and department-specified holidays.
Calendar day	Every day the calendar shows, including Saturdays, Sundays, and department-specified holidays.
Certificate of compliance	A document, provided by a manufacturer, producer, or supplier of a product, stating that the product as furnished to the contractor complies with the pertinent specifications and contract requirements.

Certified report of test or analysis	A certified test report, provided by a manufacturer, producer, or supplier of a product, indicating that actual results of tests or analyses comply with the elements of the specification requirements.
Completion date	The calendar date shown in the proposal on or before which the work contemplated under the contract shall be completed.
Construction limits	The limits of grading or other work generally defined by slope stakes offset from the actual slope intercepts or limits of the work.
Consulting firm	The individual, partnership, joint ventures, corporation, or agency contracted by the department to act directly or as a duly authorized construction representative providing services for the department.
Contract	<p>The written agreement between the department and the contractor setting forth the obligations of the parties to the contract, including, but not limited to, performance of the work, furnishing of labor and materials, and basis of payment.</p> <p>The contract includes the notice to contractors, proposal, contract form, contract bond, standard specifications, supplemental specifications, interim supplemental specifications, special provisions, addenda, general plans, detailed plans, notice to proceed, and contract change orders and agreements required to complete the construction of the work in an acceptable manner, including authorized extensions, all of which constitute one instrument.</p>
Contract bond	The department-approved form of security, executed by the contractor and the contractor's surety or sureties, guaranteeing the performance of the contract work, completion of the contract requirements, and the payment of claims as provided in 779.14 of the Wisconsin statutes.
Contract change order	A written order or authorization executed by the engineer covering work not otherwise provided for in the contract, revisions in or amendments to the contract, or conditions specifically prescribed in the specifications as requiring contract change orders. The change order document becomes a part of the contract when executed by the department.
Contract modification	<p>Any change to the contract made after it is executed, including but not limited to, the following:</p> <ul style="list-style-type: none"> - A contract change order. - A supplemental contract agreement. - An administrative change adding a non-bid item. - A general administrative change.
Contract period	The period from the specified date of commencing work to the date that the specified number of calendar or working days has elapsed, both dates inclusive, or from the specified date of commencing work to the specified completion date, both dates inclusive; as specified in the contract.
Contract revision	See: contract modification
Contract time	The number of calendar or working days shown in the proposal representing the time allowed for the completion of the work contemplated in the contract.
Contractor	The individual, partnership, joint venture, corporation, limited liability company, limited liability partnership, or agency undertaking the performance of the work under the terms of the contract and acting directly or through a duly authorized representative.
Controlling item of work	An activity shown on the project schedule, that if delayed, delays completion of the project.
Culvert	A structure not classified as a bridge that provides an opening under a roadway.
Department	The Wisconsin Department of Transportation.
Detour	An existing, permanent road designated as a temporary route to carry vehicular traffic around a section of a highway closed to through traffic.
District	The department's transportation district office.

Divided highway	A highway with separate roadways for traffic in opposite directions.										
Engineer	The secretary of the department of transportation or the secretary's authorized representative limited by the particular duties assigned to the representative.										
Equipment	All machinery and articles necessary for the proper construction and acceptable completion of the work. This includes the supplies, tools, and apparatus for upkeep and maintenance of the equipment.										
Erosion control implementation plan	The erosion control implementation plan, or ECIP, as required under Trans 401 of the Wisconsin administrative code.										
Extra work	All work performed by the contractor, with approval of the engineer, that does not appear in the proposal or contract as a specific bid item accompanied by a unit price, and that is not included under the price bid for other bid items in the contract. Extra work may also consist of additions to, or changes in, design of contract bid items or portions of contract bid items, if additions are wholly disassociated from or outside the scope of work in the contract, and if the work caused by these additions or changes must be performed under conditions or in a manner materially different from the conditions and manner existent for contract bid items under the original scope of work.										
Force account	A method of payment based on the cost of labor, equipment, materials furnished, and consideration for overhead and profit as specified in 109.4.5 .										
Frontage road or street	A local road or street auxiliary to and located along the side of an arterial highway for service to abutting property and adjoining areas and for control of access.										
Hazardous substance	A substance or combination of substances, including waste of a solid, semisolid, liquid, or gaseous form, that may cause or significantly contribute to an increase in mortality or an increase in serious, irreversible, or incapacitating, reversible illness, or that may pose a substantial present or potential hazard to human health or the environment.										
Highway separation	A structure carrying highway traffic over or under another highway or street.										
Highway, street, or road	A public way for the purpose of vehicular travel, including the entire area within the right-of-way.										
Holidays	The following days are department-specified holidays for use in determination of working days: <table> <tr> <td>New Year's day</td><td>Labor day</td></tr> <tr> <td>New Year's Eve day</td><td>Thanksgiving day</td></tr> <tr> <td>Martin Luther King Jr. day</td><td>Christmas Eve day</td></tr> <tr> <td>Memorial day</td><td>Christmas day</td></tr> <tr> <td>Independence day</td><td></td></tr> </table>	New Year's day	Labor day	New Year's Eve day	Thanksgiving day	Martin Luther King Jr. day	Christmas Eve day	Memorial day	Christmas day	Independence day	
New Year's day	Labor day										
New Year's Eve day	Thanksgiving day										
Martin Luther King Jr. day	Christmas Eve day										
Memorial day	Christmas day										
Independence day											
Inspector	The authorized representative of the engineer assigned to make inspection of all portions of the work or materials.										
Interchange	A highway separation with access connections between the highways.										
Interim supplemental specifications	Written directions and requirements adopted subsequent to the publication of the supplemental specifications that amend the supplemental specifications.										
Laboratory	The materials testing laboratory of the department or other testing laboratory designated by the engineer.										
Local road or street	A street or road used primarily for access to residences, businesses, or other abutting property.										
Local traffic	Passage of vehicles, people, and goods originating within, or having a destination on, the portion of the highway closed to through traffic as specified in the contract.										

Major and minor bid items	A major bid item is a bid item whose total cost, determined by multiplying the bidding schedule quantity and the contract unit price, is equal to or greater than 5 percent of the total amount of the original contract. All other bid items are minor bid items. A minor bid item, when its quantity is increased, becomes a major bid item if it meets this 5 percent criterion.
Materially unbalanced bid	A bid that generates a reasonable doubt that award to the bidder submitting a mathematically unbalanced bid will result in the lowest ultimate cost to the department.
Mathematically unbalanced bid	A bid containing lump sum or unit price bid items that do not reflect reasonable anticipated actual costs of labor, equipment, materials, plus a reasonable proportionate share of the bidder's anticipated profit, overhead costs, and other indirect costs.
Materials	Substances specified for use in the construction of the work. See also: new material, reclaimed asphaltic pavement material, recovered material, recycled material, and special waste.
Median	The portion of a divided highway separating the traveled ways for traffic in opposite directions.
New material	Material not used for another purpose before incorporation into the work.
Notice to contractors	The advertisement for proposals for all work or materials on which bids are required. The advertisement will indicate with reasonable accuracy the quantity and location of the work to be done, or the character and quantity of the material to be furnished, and the time and place of submitting and opening the proposals.
Notice to proceed	A written notice from the engineer to the contractor of the time period within which the prosecution of the work shall begin.
Pavement structure	The combination of subbase, base, and surface course placed on a subgrade to support the traffic load and distribute it to the roadbed.
Plans	The department-approved plans, profiles, typical cross-sections, working drawings, and supplemental drawings that show the location, character, dimensions, and details of the work to be done.
Plant names and labels	The plant names and labels used in the nomenclature references listed in the current edition of the American Standard for Nursery Stock.
Project	The designated physical area together with all improvements to be constructed under the contract.
Project engineer	The authorized representative of the engineer having direct supervision of the administration of the contract.
Proposal	The written offer of the bidder, submitted on the prescribed proposal form, to perform the work at the prices quoted by the bidder; also commonly known as the "bid."
Proposal guaranty	The security furnished with a bid to guarantee that the bidder will enter into the contract if the bid is accepted.
Quality management program	The department's specifications defining both department and contractor responsibilities for assuring quality construction. The specifications provide for the following: <ol style="list-style-type: none"> 1. Contractor assurance defines optional contractor sampling and testing to assure the accuracy of the QC test results. 2. Quality control defines the required contractor sampling and testing the department uses to determine specification conformance. 3. Quality verification defines the department sampling and testing the department uses to validate the quality of the final product. 4. Independent assurance defines the activities the department uses to evaluate the QC and QV sampling and testing procedures. 5. Dispute resolution defines the procedures the department uses to resolve disputes over conflicting test results for nonconforming work.

Reclaimed asphaltic pavement material	A recovered material from existing asphaltic pavement.
Recovered material	A product recovered from solid waste in a form identical to the original form, for a use that is the same or similar to the original use.
Recycled material	A product manufactured from previously used products.
Review panel	The department's claims review panel.
Responsible bidder	A bidder determined by the department to possess the ability to perform the contract work and complete the contract requirements.
Right-of-way	Land, property, or interest in land or property acquired for or devoted to transportation purposes.
Roadbed	The graded portion of a highway, within top slopes and side slopes, prepared as a foundation for the pavement structure and shoulders.
Roadside	The area adjoining the outer edge of the roadway. Areas between the roadways of a divided highway may also be considered roadside.
Roadway	The portion of a highway within the limits of construction. A divided highway has 2 or more roadways.
Roadway foundation	The area underlying the proposed roadway within the limits of assumed one-to-one slopes extending outward and downward from the subgrade shoulder points.
Schedule of items	The prepared schedule, included as a part of the proposal form, containing the estimated quantities of the pay items for which unit bid prices are invited.
Secretary	The secretary of the Wisconsin Department of Transportation.
Semi-final estimate	A tentative final estimate indicating that the engineer has measured and reported all quantities. The department prepares and submits a semi-final estimate for the contractor's review before issuing a final estimate.
SI metric	The International System of Units for metric measure.
Shoulders	The portions of the roadway contiguous with the traveled way for accommodation of stopped vehicles, emergency use, and lateral support of base and surface courses.
Shop drawings	Stress sheets, working drawings, erection plans, falsework plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel, or other supplementary plans, computations, or similar data that the contractor is required to submit to the engineer.
Sidewalk	The portion of the roadway constructed primarily for the use of pedestrians.
Special provisions	Written directions and requirements applicable to a specific project and not otherwise thoroughly or satisfactorily detailed or prescribed in the standard specifications or supplemental specifications.
Special waste	Solid waste characterized for beneficial use in public works projects by the WDNR under section 895.58 of the Wisconsin statutes.
Specifications	Written directions, provisions, and requirements contained in the standard specifications, supplemental specifications, interim supplemental specifications, or special provisions, together with written agreements and documents referenced in the contract, pertaining to the method or manner of performing the work, the quantities of work, and the quality of materials to be furnished under the contract; as made part of the contract and contained in or referenced in the proposal. See also: interim supplemental specifications, special provisions, standard specifications, and supplemental specifications
Stabilization	Modification of soils or aggregates by incorporating materials that will increase load bearing capacity, firmness and resistance to weathering or displacement.
Standard specifications	Written directions and requirements approved for general application and repetitive use as contained herein for highway and structures construction and for administration of the contract.

State	The state of Wisconsin.
Subbase	The layer or layers of specified or selected material of designed thickness placed on a subgrade to support base.
Subcontractor	The individual, partnership, corporation, limited liability company, or joint venture to which the contractor, with the department's written consent, sublets part of the contract.
Subgrade	The top surface of a roadbed upon which the pavement structure and shoulders are constructed.
Substructure	All of the bridge below the bridge seats or below the tops of the caps of piling or framed trestles, including the wing walls, backwalls, and parapets of abutments.
Superintendent	The contractor's authorized representative in responsible charge of the work.
Superstructure	All of the bridge above the bridge seats or above the tops of caps of piling or framed trestles, including flooring, but excluding wing walls, backwalls, and parapets of abutments.
Supplemental contract agreement	A written agreement between the engineer and contractor to pay for a particular bid item using the plan quantity rather than measure the actual quantity of work acceptably completed.
Supplemental specifications	Written directions and requirements adopted subsequent to the publication of the standard specifications that amend the standard specifications.
Surety	The company executing a contract bond with the contractor.
Surface course	One or more layers of a pavement structure, the top layer of which resists skidding, traffic abrasion, and the disintegrating effects of climate.
Traffic lane	The portion of a traveled way for the movement of a single line of vehicles.
Traveled way	The portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.
Unacceptable work	Work that does not conform to the contract and results in a product that is insufficient to fulfill the needs of the project.
Unbalanced bid	See: materially unbalanced bid and mathematically unbalanced bid
US standard	The US standard measure system of units for english measure.
Work	The furnishing of all labor, materials, equipment, and incidentals and the performing of all tasks needed to complete the project or a specific part of the project as specified in the contract, together with fulfillment of all associated obligations and duties required by the contract.
Working day	A calendar day, except Saturdays, Sundays, department-specified holidays, and the period from November 16 to March 31, both dates inclusive, on which weather or other conditions not under the control of the contractor will allow construction operations to proceed for at least 8 hours of the day with the normal working force engaged in performing the controlling item of work which would be in progress at this time.

SECTION 102 BIDDING REQUIREMENTS AND CONDITIONS

102.1 Prequalifying Bidders

- (1) The department will provide, upon request, information regarding departmental policy and procedures for prequalification of a bidder.
- (2) Furnish a dated prequalification statement on the department's form at least 5 calendar days before the time set for opening proposals. Include certificates for insurance Types 1, 2 and 3 as required in [107.26](#).
- (3) The prequalification statement establishes proof of the prospective bidder's competency and responsibility to perform work. The department will evaluate each prospective bidder based on verified information in the prequalification statement and on other relevant information the department may have. The department will assign ratings, honoring all limitations requested by the bidder, as provided in the departmental policy. The department will maintain the bidder's ratings for a period of time provided in the departmental policy.
- (4) The department will indicate, in the notice to contractors, if a contract does not require prequalification.

102.2 Bidding Proposal Content

- (1) The bidding proposal is the department-required form the prospective bidder must use to prepare and submit bids for the work. The department will provide the bidding proposal that includes:
 1. The name and bidder identification number of the prospective bidder.
 2. Location and description of the project.
 3. Estimate of quantities and type of work to be performed or materials to be furnished.
 4. Time to complete the work.
 5. Amount of the proposal guaranty.
 6. Department's deadline for receiving completed proposals.
 7. Schedule of items.
 8. Contract requirements not contained in the standard specifications.
 9. Special provisions.
- (2) Documents bound with or attached to the bidding proposal are a part of the proposal. Do not detach or alter bound documents when submitting the proposal. The plans, interim supplemental specifications, supplemental specifications, standard specifications, and other documents designated in the bidding proposal are a part of the proposal, whether attached or not, and need not be returned when the proposal is submitted.

102.3 Issuing Bidding Proposals

102.3.1 General

- (1) The department will provide, upon request, information regarding departmental policy and procedures for obtaining bidding information, submitting a bid, obtaining sample proposal forms, and purchasing plans.
- (2) To obtain the bidding proposal, the prospective bidder shall prequalify as specified in [102.1](#) unless the department indicates in the notice to contractors that prequalification will not be required. Submit a written request for a bidding proposal on the department's request for proposal form.

102.3.2 Department May Not Issue

- (1) The department may refuse to issue bidding proposals to a prospective bidder for one or more of the following reasons:
 1. The department's estimate of the cost of the proposal, together with the value of the prospective bidder's uncompleted contract work, exceeds the prospective bidder's established ratings, as determined in [102.1](#), at the time set for receiving proposals.
 2. The prospective bidder owes the department for previously issued plans.
 3. The prospective bidder has work under way or has performed work not up to the proper standard of progress or quality. The prospective bidder may request, in writing, that the department review its refusal to issue a bidding proposal as provided in the department's prequalification policy.

4. The award of additional work, in the department's opinion, would preclude the satisfactory performance of the additional work or work already under way. The prospective bidder may request, in writing, that the department review its refusal to issue a bidding proposal as provided in the department's prequalification policy.
5. Any of the causes for disqualification of a bidder specified in [102.13.2](#).

102.3.3 Department Will Not Issue

- (1) The department will refuse to issue bidding proposals to 2 or more prospective bidders on the same contract who are affiliated with each other, or for one or more of the following reasons:
 1. The prospective bidder has been suspended or debarred from bidding on department contracts under Trans 504 of the Wisconsin administrative code.
 2. The prospective bidder does not supply, on the department's request for proposal form, the required information on all incomplete work.

102.4 Interpreting Bid Proposal Quantities

- (1) Submit unit bid prices for the estimated quantities as given in the schedule of items. These quantities are approximate and the department only uses them for the comparison of bids. Do not plead misunderstanding or deception because of these quantities as to the character, location, or other conditions pertaining to the work.
- (2) The department will only pay the contractor for the actual quantities of the work performed or materials furnished under the contract. The department may increase or decrease the contractor's scheduled quantities of work as provided in [109.3](#) without invalidating the bid prices.

102.5 Examining Contract Documents and Work Site

- (1) Carefully examine the contract documents and perform a reasonable site investigation before submitting a proposal. Submitting a proposal is an affirmative statement that the bidder has investigated the site and is satisfied as to the character, quality, quantities, and the conditions the bidder will encounter in performing the work that the bidder could determine by walking the project site. A reasonable site investigation also includes investigating borrow sites, hauling routes, and all other locations related to the performance of the work.
- (2) Before the department's execution of the contract, obtain a permit from the department before performing excavations, borings, or other activities within the highway right-of-way. Obtain the necessary permit request forms from the district operations engineer.
- (3) The department may include in the contract documents, or make available for the bidder's review at the department's district or other offices, one or more of the following:
 1. As built drawings.
 2. Available information relative to subsurface exploration, borings, soundings, water levels, elevations, or profiles.
 3. The results of other preliminary investigations.
- (4) The department provides information under 102.5(3) for the bidder's general knowledge only. This information is not a substitute for the bidder's own investigation, interpretation, or judgment. The information provided is applicable only to the locations and at the times indicated.

102.6 Preparing the Proposal

- (1) Submit completed proposals on the department's bidding proposal described in [102.2](#). Submit legible information only. Write everything in ink, by typewriter, or by computer-controlled printer. Provide all dollar amounts in dollars and cents, in numerals. Attach all addenda to the submitted proposal.
- (2) Properly execute the proposal. Place the required signatures, in ink, in the space provided on the bidding proposal as indicated below:

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 that corporation and affix the corporate seal.

Limited liability company A manager, a member, or a duly authorized agent.

- (3) Instead of using the schedule of items provided on the department's bidding proposal, the bidder may submit a substitute schedule with the proposal. Use a format for the substitute schedule conforming to the department's guidelines for approval of a bidder-generated schedule of items. Obtain the department's written approval before using a substitute schedule.
- (4) Provide a unit price for each bid item listed in the schedule of items. Calculate and show, in the bid amount column, the products of the respective unit prices and quantities. For a lump sum bid item, show the same price in the unit price column and in the bid amount column pertaining to that bid item. Show the total bid obtained by adding the values entered in the bid amount column for the listed bid items.
- (5) If a unit price or lump sum bid already entered in the proposal needs to be altered, cross out the entered unit price or lump sum bid with ink or typewriter and enter the new price above or below and initial it in ink.
- (6) A change that the bidder makes in the proposal is not an alteration if the bidder makes that change as directed in a specific instruction contained in an addendum.

102.7 Irregular Proposals

102.7.1 Department Will Correct

102.7.1.1 All Schedules of Items

- (1) The department will correct arithmetic errors or omissions found in the completed schedule of items as follows:
 - 1. Discrepancy between a unit price and the corresponding bid amount, or in the absence of a bid amount: the department will use the unit price to determine the correct bid amount.
 - 2. Bidder leaves the unit price column or the bid amount column blank for a lump sum bid item: the department will use the single value shown to obtain the correct unit price and the correct bid amount for that bid item.
 - 3. Discrepancy between the total bid and the sum of the correct bid amounts, or in the absence of a total bid: the department will use the correct bid amounts to determine the correct total bid.

102.7.1.2 Bidder-Generated Schedules of Items

- (1) The department will also correct errors in bidder-generated schedules of items as follows:
 - 1. Quantity is incorrect, and both the bid item number and description are correct: the department will correct the quantity and recalculate the bid amount.
 - 2. Item number is correct and the description is incorrect: the department will correct the description.
 - 3. Item number is incorrect and the description is correct: the department will correct the bid item number.
 - 4. Item number is correct but out of sequence and the description is correct: the department will ignore the error.

102.7.2 Department May Reject

- (1) Proposals are irregular and the department may reject them for one or more of the following reasons:
 - 1. The proposal contains unauthorized alterations of format, words, or figures.
 - 2. The schedule of items contains errors, alterations, or omissions in, bid item numbers, quantities, descriptions, or units of measure, that cannot be corrected as specified in [102.7.1](#).
 - 3. The proposal is not prepared as specified in [102.6](#).
 - 4. There are unauthorized alterations, additions, conditional or alternate bids, amendments, attachments, or irregularities that may tend to make the proposal incomplete, indefinite, or ambiguous as to its meaning.
 - 5. There are unauthorized erasures or alterations appearing on the designation of the party to whom the department issued the bidding proposal.
 - 6. The award of the bid, together with the value of the bidder's uncompleted contract work, exceeds the bidder's established ratings, as determined in [102.1](#), at the time set for awarding the work.
 - 7. A single entity, under the same or different names, or affiliated entities submit more than one proposal for the same work. The submitting entity may be an individual, partnership, joint venture, corporation, or limited liability company.

102.7.3 Department Will Reject

- (1) Proposals are irregular and the department will reject them if the bidder:
 1. Does not furnish the required proposal guaranty in the proper form and amount as specified in [102.8](#).
 2. Does not submit a unit price for each bid item listed, except for lump sum bid items where the bidder may show the price in the bid amount column for that bid item.
 3. Includes conditions or qualifications not provided for in the department-supplied bidding proposal.
 4. Submits a bid on a bidding proposal issued to a different bidder without obtaining departmental authorization to do so.
 5. Submits a bid that contains unauthorized revisions in the name of the party to whom the bidding proposal was issued.
 6. Submits a schedule of items with illegibly printed bid item numbers, descriptions, or unit prices.
 7. Submits a schedule of items for the wrong contract.
 8. Submits a bidder-generated schedule of items with an incorrect bid item number and incorrect description for a single bid item.
 9. Omits a bid item or bid items on a bidder-generated schedule of items.
 10. Submits a materially unbalanced bid.
 11. Does not sign the proposal.

102.8 Proposal Guaranty

- (1) The department will reject and will not read a proposal submitted without a proposal guaranty in the amount designated and payable to the party designated in the notice to contractors. Submit the required proposal guaranty in one of the following forms:
 1. Properly executed project bid bond submitted on the department's form.
 2. Properly executed annual bid bond submitted on the department's form.
 3. Certified check drawn on the account of the bidder submitting the proposal.
 4. Bank's check.
 5. Cashier's check.
 6. Postal money order.
- (2) When submitting a bid bond, ensure that the surety is licensed to do business in Wisconsin and has an equivalent A.M. Best rating of A- or better.
- (3) 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 proposal bid.
- (4) If the department invites combined bids and the bidder elects to bid one or more individual proposal in addition to the combined proposal, the bidder must submit a proposal guaranty in the amount required for the combined proposal. The combined proposal guaranty covers each individual proposal bid.

102.9 Proposal Delivery

- (1) Place each proposal, together with the proposal guaranty, in a sealed envelope, furnished by the department. On each envelope, indicate the proposal number and the name of the bidder. For mailed submittals, mark the sealed proposal as indicated above and enclose in an additional envelope. The department will accept proposals at the place, until the hour, on the date designated in the notice to contractors. The department will return proposals received after the designated time to the bidder unopened.

102.10 Withdrawing or Returning Proposals

- (1) Provide a written request to withdraw a proposal already filed with the department. Submit the withdrawal request before the deadline set for receiving proposals. The bidder named on a withdrawn proposal cannot subsequently bid on that contract unless the department issues a new invitation for bids.

- (2) The department may withdraw a bidding proposal already issued or return unopened a proposal already filed with the department if, after issuing the bidding proposal, the bidder is found to be ineligible to bid on that contract.

102.11 (Vacant)

102.12 Public Opening of Proposals

- (1) The department will publicly open proposals at the time and place indicated in the notice to contractors. The department will read the total bid for each proposal except as specified in [102.8](#). If a proposal has no total bid shown, the department will announce "no total."
- (2) Bidders or their authorized agent and other interested persons are invited to be present.
- (3) The department may postpone the receipt of bids time or the opening of bids time due to emergencies or unforeseen conditions. If the department changes the hour or the date of the receipt of bids time or the opening of bids time, the department will issue an addendum or public notice to notify prospective bidders.

102.13 Disqualification of Bidders

102.13.1 General

- (1) If the department disqualifies a bidder, the department will notify that bidder in writing. The department will give the reason for disqualification, the term of disqualification, and instructions for reestablishing eligibility to bid on departmental contracts.

102.13.2 Department May Disqualify

- (1) The department may disqualify the bidder from further bidding for a period of time determined by the department for one or more of the following reasons:
 - 1. The department has notified the bidder that it has initiated a debarment or suspension action against the bidder under Trans 504 of the Wisconsin administrative code.
 - 2. Developments, subsequent to establishment of a bidder's competency and qualifications, which in the department's judgment affect the responsibility of the bidder.
 - 3. Not complying, within a reasonable time, with the department's request to update a prequalification statement.

102.13.3 Department Will Disqualify

- (1) The department will disqualify the bidder from further bidding, for a period of time the department determines, if the bidder has been suspended or debarred from bidding on department contracts under Trans 504 of the Wisconsin administrative code.

SECTION 103 CONTRACT AWARD AND EXECUTION

103.1 Consideration of Proposals

- (1) Following the public opening and reading of the proposals received, the department will compare them on the basis of the summation of the products of the quantities of work listed and the contract unit prices offered. In case of discrepancies, errors, or omissions, the department will make corrections as specified in [102.7.1](#). In awarding contracts, the department, in addition to considering the amounts stated in the proposals, may consider one or more of the following:
 1. The responsibility of the various bidders as determined from a study of the data required under [102.1](#).
 2. The information required on the bidding proposal.
 3. Information from other investigations that the department may make.
- (2) The department will also review the proposals for the irregularities described in [102.7](#) and review the eligibility of the bidder as specified in [102.13](#). The department will determine whether irregularities are matters of form rather than substance and can be waived without prejudice to other bidders or the public interest.
- (3) The bidder may submit individual proposals for more than one contract being let. Although each individual proposal may not exceed the bidder's rating, a combination of more than one proposal and incomplete work currently under contract may exceed the bidder's rating. If the bidder exceeds its rating, the department may award a proposal or combination of proposals that are within the bidder's rating and most advantageous to the department.
- (4) The department may reject any or all proposals, or waive technicalities. The department, in its own interest, may re-advertise for bids or proceed with the work in another manner.

103.2 Awarding the Contract

- (1) Unless rejecting all proposals, the department will award the contract to the lowest responsible bidder whose proposal complies with 103.1.
- (2) The bidder, by written notice before the time set for opening of bids, may limit the bidder's total dollar volume of work or number of contracts to be awarded in a letting, and the department will determine which contract or contracts to award.
- (3) If the department does not make an award within 30 calendar days after opening the proposals, the lowest responsible bidder, after those 30 days, may request, in writing, that the department make the award. Stipulate a deadline of 10 business days or more, after the date of the request, for the department to make the award. If the department does not make the award within the stipulated time, the bidder is relieved of its obligation to execute a contract and contract bond.

103.3 Canceling the Award

- (1) The department may cancel a contract award before execution without liability.

103.4 Returning Proposal Guaranty

- (1) The department will return the proposal guaranties of all except the lowest responsible bidder within 5 business days after determining the lowest qualified bidder. The department will return the lowest responsible bidder's proposal guaranty as soon as the bidder executes and submits in the proper form the contract, contract bond, and other required documents.
- (2) If the department does not make the award within the time stipulated by the lowest responsible bidder as specified in 103.2(3), the department will return their proposal guaranty within 5 business days after that deadline.

103.5 Contract Bond

- (1) At the time of submitting the contract for execution by the department, deposit a valid surety bond with the department in the amount designated on the bond form covering both performance and payment.
- (2) Submit the contract bond on a department furnished form. The surety is subject to the department's approval, and to the governor's approval, if required by law.

103.6 Executing and Approving the Contract

- (1) The bidder shall execute the contract. The principal and the sureties shall execute the contract bond. Present the contract, the contract bond, and all other department-required forms within 14 calendar days after the date of notice of the award of the contract.
- (2) The contract is not binding on the department until the final execution of the contract. The contract final execution date is the date the final signer signs the contract.

103.7 Failure to Execute Contract

- (1) The department may cancel the award if, within 14 calendar days after the date of notice of the award of the contract, the successful bidder does not do the following:
 - 1. Return required forms or supply other department requested information.
 - 2. Execute a contract and contract bond, as provided in 103.6.
- (2) If the department cancels the award, the department may retain the proposal guaranty, not as a penalty, but in payment of liquidated damages the department sustains due to the bidder's failure to execute. If the retained proposal guaranty is a bid bond, pay the department the proposal guaranty amount within 10 business days of demand.

103.8 Nullifying the Award

- (1) The department will accept the bidder's request to nullify and will nullify the bidder's acceptance of the contract if the following conditions are met:
 - 1. The bidder files the required contract documents in proper form and order.
 - 2. The department does not execute the contract within 30 calendar days after the bidder files the required contract documents.
 - 3. The bidder files a written request to nullify with the department. Wait the 30 days specified in item 2 before filing that request. Stipulate in the request a deadline for the department to execute the contract. This deadline must be 10 business days or more after the filing date of the request.
 - 4. The department does not execute the contract within the stipulated deadline.
- (2) The department will notify the bidder, in writing, if the department agrees to nullify the award. The department's failure to act within the stipulated deadline also constitutes nullification.
- (3) The request to nullify is a voluntary act of the bidder. The department's nullification relieves the bidder, the bidder's surety, and the department of all obligations under the award.
- (4) Unless and until the bidder files a request to nullify, and until the department nullifies, the department may execute the contract without prejudice to any contract terms and conditions.

SECTION 104 SCOPE OF WORK

104.1 Intent of the Contract

- (1) The intent of the contract is to provide for the construction, execution, and completion of the work. Perform the work as specified in the contract.

104.2 Revisions to the Contract

104.2.1 General

- (1) The department reserves the right to revise the contract at any time. These revisions do not invalidate the contract or release the surety. The contractor agrees to complete the contract as revised. Do not proceed with the revised work without the engineer's prior written approval. Upon receiving written approval, proceed immediately with the revised work.
- (2) The contractor shall notify the engineer if the contractor believes a revision to the contract is necessary. Whenever the words notice, notification, or notify are used in 104.2 with reference to the contractor, the contractor shall provide notice as specified in [104.3](#). The engineer will determine if a potential contract revision is necessary and will inform the contractor of its determination in writing. The contractor must proceed with the engineer's direction.
- (3) If the engineer determines that a revision is necessary, the engineer will revise the contract time as specified in [108.10](#) and will revise the contract price as specified in [109.4](#). The contractor is entitled to no reimbursement for loss of anticipated profit.
- (4) If the engineer decides that a potential contract revision identified by the contractor is not necessary, and the contractor does not agree with the engineer's decision, the contractor may pursue a claim under [105.13](#).

104.2.2 Issuing Contract Change Orders

104.2.2.1 Change Orders for Extra Work

- (1) The department will issue a contract change order to accomplish extra work as defined in [101.3](#).

104.2.2.2 Change Orders for Differing Site Conditions

- (1) During the progress of the work, if one or more of the following differing conditions are encountered at the site, the party discovering the condition shall promptly notify the other party of the specific condition before further disturbing the site and before further performing the affected work.
 1. A subsurface or latent physical condition, differing materially from those indicated in the contract.
 2. An unknown physical condition of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the work specified in the contract.
- (2) If the contractor discovers the differing condition, the contractor shall provide oral notification as specified in [104.3.2](#), of the specific differing condition before further disturbing the site and before further performing the affected work.
- (3) The engineer will investigate the conditions. If the engineer determines that the conditions materially differ and cause an increase or decrease in the cost, time, or both, required to perform the work under the contract, the engineer will adjust the contract price, time, or both, and modify the contract in writing accordingly. The engineer will respond to the contractor as to whether or not an adjustment is warranted. The engineer will follow the contractor notification procedures specified in [104.3](#).
- (4) The department will not allow a contract adjustment unless the contractor has provided the required notice as specified in [104.3](#).

104.2.2.3 Change Orders for Engineer-Ordered Suspensions

- (1) If the engineer suspends or delays the performance of all or any portion of the work in writing for an unreasonable period of time (not originally anticipated, customary, or inherent to the construction industry) and the contractor believes that additional payment, contract time, or both, is due because of the suspension or delay, the contractor shall submit a written request for adjustment within 7 calendar days of receipt of the engineer's directive to resume work. Ensure that the content of the request conforms to [104.3.5](#).

- (2) The engineer will evaluate the contractor's request. If the engineer agrees that the cost, time, or both, required for the performance of the contract has increased due to the suspension or delay and the suspension or delay 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 adjustment and modify the contract in writing accordingly. The engineer will respond to the contractor as to whether or not an adjustment is warranted as specified in [104.3.6](#).
- (3) The engineer will not consider a contract adjustment unless the contractor submits the request for adjustment within the time specified above.
- (4) The engineer will not consider a contract adjustment under this clause to the extent that the performance would have been suspended by any other cause, or for which an adjustment is provided or excluded under any other term or condition of this contract.

104.2.2.4 Change Orders for Significant Changes in the Character of the Work

- (1) The department will adjust the contract if alterations or changes in quantities significantly change the character of the work under contract as follows:
 - 1. The character of the work as altered differs materially in kind or nature from that involved or included in the original proposed construction.
 - 2. The department or contractor demonstrates that quantity changes materially affect the character of the work and meet one of the following:
 - 2.1 The quantity of a major bid item, as defined in [101.3](#), is increased in excess of 125 percent or decreased below 75 percent of the original contract quantity. Any allowance for an increase in quantity applies only to that portion in excess of 125 percent of the original contract bid item quantity, or in case of a decrease below 75 percent, to the actual amount of work performed.
 - 2.2 The quantity of a minor bid item is increased to become a major bid item. An adjustment in the contract unit price for that bid item applies only to the quantity of that bid item having a contract value, determined from the contract unit price, in excess of 6.25 percent of the total amount of the original contract.
 - 2.3 The quantity of a minor bid item that is part of an approved subcontract and that exceeds 10 percent of the original value of that subcontract is decreased more than 50 percent from the original contract quantity for that bid item. Either party to the contract may submit a request for a revision to the contract unit price for that bid item. The department's total payment for the final reduced quantity will not exceed 75 percent of the original contract quantity at the contract price.
 - 2.4 The quantity of a minor bid item that is part of an approved subcontract and that exceeds 10 percent of the original value of that subcontract is increased more than 50 percent from the original contract quantity for that bid item and which as increased does not qualify for adjustment as a major bid item. Either party to the contract may submit a request to the other for a revision of the contract unit price for that quantity of the bid item that is in excess of 125 percent of the original contract quantity.
- (2) Before performing significantly changed work, reach agreement with the department concerning the basis for the adjustment as specified in [109.4.4](#). If the department does not acknowledge that the work has significantly changed, follow the notification procedures as specified in [104.3](#).
- (3) If the alterations or changes in quantities do not significantly change the character of the work under the contract, the department will pay for the altered work at the contract price.

104.2.2.5 Change Orders for Eliminated Bid Items

- (1) The department has the right to partially eliminate or completely eliminate a bid item the engineer finds to be unnecessary for the project. If the engineer partially eliminates or completely eliminates a bid item, the engineer will issue a contract change order for a fair and equitable amount as specified in [109.5](#).

104.2.2.6 Change Orders for Revisions to Contract Time

- (1) The department will issue a contract change order to revise the contract time as specified in [108.10](#).

104.3 Contractor Notification

104.3.1 General

- (1) Subsection 104.3 specifies the step-by-step communication process to be followed to expedite the resolution of potential contract revisions identified by the contractor. Both contractor actions and department responses are outlined. The contractor's non-compliance with the requirements of 104.3 may constitute a waiver of entitlement to a pay adjustment under [109.4](#) or a time extension under [108.10](#).

104.3.2 Contractor Initial Oral Notification

- (1) If required by [104.2](#), or if the contractor believes that the department's action, the department's lack of action, or some other situation results in or necessitates a contract revision, the contractor must promptly provide oral notification to the engineer. Upon notification, the engineer will attempt to resolve the identified issue.

104.3.3 Contractor 2-Day Written Notice

- (1) If the engineer has not resolved the identified issue within 2 business days after receipt of oral notification, provide a contractor 2-day written notice to the engineer. At a minimum, provide the following:
 1. A written description of the nature of the issue.
 2. The time and date of discovering the problem or issue.
 3. If appropriate, the location of the issue.
- (2) The contractor is encouraged to provide the additional information specified in 104.3.5 as early as possible to assist the engineer in the timely resolution of an identified issue. The engineer will not require, in subsequent submissions, duplication of information already provided.

104.3.4 Engineer One-Day Written Acknowledgment

- (1) Within one business day after the contractor provides initial written notice, the engineer will provide an engineer one-day written acknowledgment to the contractor. The engineer will continue to resolve the issue.

104.3.5 Contractor 5-Day Written Statement

- (1) If the engineer has not resolved the issue within 5 business days from the date of the initial written notice, augment the original written notice with an additional contractor 5-day written statement to resolve the issue. In the written statement:
 1. State why the issue is a change to the original contract.
 2. Refer to the contract to show what has changed from the original contract.
 3. Provide all perceived adjustments to contract prices, delivery schedules, phasing, and contract time.
 4. Provide an estimate of the time within which the department must respond to the notice to minimize cost, delay, or disruption.
- (2) The department understands that the contractor's estimates of the time required and additional costs may be based on incomplete information. The department will attempt to comprehend and resolve the potential change as quickly as possible. The contractor can help the department in this process by providing the requested information as quickly as possible.

104.3.6 Engineer 5-Day Written Response

- (1) Within 5 business days after receiving the contractor 5-day written statement, the engineer will consider the statement and provide an engineer 5-day response in writing to the contractor with one or more of the following responses:
 1. The engineer will confirm that a contract change order is necessary as specified in [104.2](#). The engineer will give direction concerning the potential change.
 2. The engineer will deny that the contract has to be revised. The engineer will provide a statement as to why the issue is not a change to the contract. At a minimum, the engineer will respond to the contractor's issues and refer to the contract to show why the issues are not a change from the original contract.
 3. The engineer will request additional information to allow the engineer to decide whether item one or 2 of 104.3.6(1) applies. The engineer will state the information needed and date it is to be received for further review.
- (2) Once the contractor believes that the engineer has no further basis to request additional information as described in item 3 of 104.3.6(1) or disagrees with the engineer's decision in item 2 of 104.3.6(1), the contractor may pursue a claim as specified in [105.13](#).

104.4 (Vacant)

104.5 (Vacant)

104.6 Roadway Maintenance and Traffic Control

104.6.1 General

- (1) The contractor is not liable for damages to or failure of existing facilities unless the damage or failure results from the contractor's own operations, negligence, or noncompliance with the contract.
- (2) The contractor shall maintain only those facilities or portions of facilities, including the roadbed surfaces, on which construction has begun or been completed, or has been damaged by the contractor's operations or has been damaged due to the contractor's negligence or noncompliance with the requirements of the contract.
- (3) The contractor is not responsible for snow removal or ice control operations to maintain traffic on highways open to traffic or closed to through traffic.
- (4) Maintain the safety of the traveling public and control traffic using barricades, signs, and flaggers as specified in part VI, of the MUTCD and ensure that the contractor's use of the right-of-way conforms to [107.9](#). Furnish, erect, and maintain traffic control devices and facilities conforming to [section 643](#), or as the engineer directs, throughout the life of the contract. Adequately train flaggers in the methods described in the department's flagger's handbook and associated videotape before allowing them to control traffic. These provisions do not relieve the contractor of responsibility for injury or damage caused by the contractor's negligence in properly safeguarding public travel. Costs for flagging and guidance services, and signs associated with flagging and guidance, are incidental to the contract.
- (5) The contractor is responsible for all damages to the work due to failure of barricades, signs, lights, flaggers, and watchers to protect it. The engineer may order the contractor to immediately remove and replace or otherwise repair the damaged work at no additional expense to the department.

104.6.2 Temporary Roads

- (1) Construct and maintain temporary roads necessary to maintain traffic as the contract specifies or as the engineer directs. Excavate and remove those portions of temporary roads not incorporated into the final roadway section, and restore disturbed areas outside the construction limits to their original condition.
- (2) The department will pay for the construction and removal of temporary roads, included in the contract or as the engineer orders, and the associated restoration of disturbed areas. The department will pay for this construction, removal, and restoration work at the contract unit prices of the bid items used, or as extra work, if the necessary bid items are not included in the contract.
- (3) Maintain temporary roads, included in the contract or as the engineer orders, in a safe and adequate condition. The cost of maintaining these temporary roads is incidental to the contract, except during suspensions under [104.6.7](#).
- (4) The cost of constructing, maintaining, and removing temporary roads the contract does not show or the engineer did not order, is incidental to the contract.

104.6.3 Road Closed to Traffic

- (1) If the contract provides, or if the engineer orders, that the road or portions of the road be closed to all traffic, furnish, erect, and maintain the traffic control devices at the project termini and at intersecting roads along the project the contract specifies or as the engineer directs. Unless specifically required in the contract, the contractor is not responsible to maintain the pavement structure or traffic signs of the detour that may be provided for the accommodation of traffic around the portion of the road closed to traffic.
- (2) Never close a public road or portion of a public road without the engineer's specific written permission. If the contract specifies, or if the engineer orders, that a road or a portion of road is to be closed, notify the engineer at the earliest possible date of when the closure is needed so the department can make arrangements to close the road and provide detours.

104.6.4 Road Closed to Through Traffic

- (1) If the contract provides that the road or portions of the road be closed to through traffic, furnish, erect, and maintain the traffic control devices at the project termini and at intersecting roads along the project the contract specifies or the engineer directs. Also, furnish, erect, and maintain those traffic control devices within the project limits as may be required for the safe accommodation of local traffic as defined in [101.3](#). At all times conduct the work in a manner to provide safe, reasonably-direct, all-weather, 24-hour pedestrian and vehicular access to abutting properties along the highway being improved.

- (2) Unless specifically required in the contract, the contractor is not responsible to maintain the pavement structure or traffic signs of the detour that may be provided for the accommodation of traffic around the portion of the road closed to through traffic. The department will pay for surfacing and base materials that the engineer deems necessary to maintain the roadway at contract unit prices, or as extra work.

104.6.5 Opening Section of Closed Road to Traffic before Work is Completed

- (1) For contracts with the road or portions of the road closed to traffic during construction, the engineer may direct or authorize the contractor to open sections of the road to public traffic before the work is completed. The engineer may direct the contractor to open sections of the road for the convenience of the traveling public. The engineer may authorize the contractor to open sections of the road to public traffic due to the contractor's request. Do not open the road to public traffic without the engineer's written direction or written authorization. By opening sections to public traffic, the contractor is not relieved of performing the maintenance. However, the department will assume all costs for repair and maintenance solely attributable to public traffic use, and beyond the control and without fault of the contractor. These maintenance expenses include costs associated with those traffic control devices or facilities specified in this section. The engineer's direction or authorization to open sections of the road to public traffic does not constitute partial acceptance under [105.11.1](#) and waives no other contract provisions.
- (2) Furnish, erect, and maintain those traffic control devices as may be required for the safe accommodation of the traffic.
- (3) The contractor is not liable for injuries or damages sustained by a person using the opened highway except for injuries or damages resulting from the contractor's own operations, negligence, or noncompliance with the requirements for traffic control under [104.6.1](#).
- (4) Whenever opening the road or a portion of the road to traffic, conduct the remainder of the construction operations in a manner that causes the least obstruction to traffic.

104.6.6 Road Open to All Traffic

- (1) If the contract provides for the maintenance of all traffic over or along the road while undergoing improvement or reconstruction, keep the road open to all traffic. Furnish, erect, and maintain the traffic control devices as required to keep the portions of the road being used by public traffic in a condition to safely and adequately accommodate pedestrian and vehicular traffic. The department will pay for necessary work and materials to maintain the roadway at the contract unit prices of the bid items used or as extra work if the necessary bid items are not included in the contract.

104.6.7 Traffic Control and Maintenance During Suspensions of the Work

- (1) During a suspension of work as specified in [105.1](#), the contractor shall make passable and open to traffic portions of the highway under improvement and temporary roads or portions thereof as the contractor and the engineer may agree upon for temporary accommodation of necessary traffic during the period of suspension. During the period of suspension, maintain the surface of the traveled way of the temporary route or line of travel agreed upon.
- (2) When resuming work, replace or renew all work or material lost or damaged because of temporary use of the highway under improvement. Remove temporary roads and restore disturbed areas outside the construction limits to their original condition, as the engineer directs. Complete the improvements in every respect as though prosecution had been continuous and without interference, except as the contractor and the engineer may otherwise have agreed upon at the time the arrangement was made for the temporary accommodation of necessary traffic during the anticipated period of suspension.
- (3) If the reason for the suspension is beyond the control and without the fault of the contractor, the department will pay for the following at the contract unit prices of the bid items used, or as extra work if the necessary bid items are not included in the contract.
 - 1. The replacement of materials and additional work made necessary because of the temporary use of the highway.
 - 2. The construction and removal of temporary roads needed for public travel during the suspension, and the corresponding restoration of disturbed areas outside the construction limits.
 - 3. Maintaining the surface of the traveled way of temporary roads used by the public during the period of suspension.
 - 4. The furnishing, erecting, and maintenance of those traffic control devices and facilities needed to safely accommodate public travel during the suspension.

104.7 Removing Structures and Obstructions

- (1) Remove from within the roadway all or parts of existing culverts, bridges, and miscellaneous structures designated for replacement or that interfere with new construction. The department will:
 1. Pay for removing existing culverts and bridges as specified in [203.5](#).
 2. Pay for removing existing miscellaneous structures as specified in [204.5](#), if the contract contains separate removal bid items under section 204.
 3. Pay for removing existing miscellaneous structures as follows, if the contract does not contain separate removal bid items under section 204:
 - 3.1. Pay as incidental to the applicable Excavation for Structures bid item, if the removal is located within the limits of an Excavation for Structures bid item under section 206.
 - 3.2. Otherwise, pay as incidental to the Excavation bid items under section 205.
- (2) Remove all or parts of existing culverts, bridges, and miscellaneous structures from beyond the roadway, but within the highway, if the contract specifies. Within 104.7, highway means the entire highway right-of-way, including abutting portions of existing highways. The department will:
 1. Pay for removing existing culverts and bridges, as specified in [203.5](#).
 2. Pay for removing existing miscellaneous structures as specified in [204.5](#), if the contract contains separate removal bid items under section 204.
 3. Pay for removing existing miscellaneous structures as follows, if the contract does not contain separate removal bid items under section 204:
 - 3.1. Pay as incidental to the Obliterating Old Road bid item, if the removal is located within the limits of the Obliterating Old Road bid item under section 214.
 - 3.2. Otherwise, pay as incidental to the other contract bid items.
 4. Pay for removals as extra work, if they are not specified in the contract but subsequently required.
- (3) Leave structures beyond the limits of the highway in place.

104.8 Rights in the Use of Materials Found on the Project

- (1) The contractor may use on the project stone, gravel, sand, or other material found within the vertical and horizontal excavation limits the plans show. Ensure that the engineer determines the material's suitability before using it. The department will pay for both the excavation of these materials at the corresponding contract bid price and the bid item for which the excavated material is used. The department will not charge the contractor for the materials found within the above described excavation limits and so used. Replace, at no expense to the department, with other acceptable material all of the excavation material so removed and used for embankments, backfills, approaches or otherwise.
- (2) Do not excavate or remove material from within the right-of-way that is not within the vertical and horizontal excavation limits the plans show without the engineer's written authorization. Do not base bids on the anticipated approval of a request to excavate or remove material that is not within the above described excavation limits.
- (3) Take ownership of all materials required to be removed and not necessary for the work.

104.9 Final Cleanup

- (1) Upon completion of the work and before the department accepts the work as specified in [105.11.2](#) and makes final payment as specified in [109.7](#), the contractor shall remove from the right-of-way, and to the extent that the contractor is responsible therefore, from the adjacent property, all surplus and discarded materials, rubbish, and temporary structures. Leave the right-of-way in a neat and presentable condition. The contractor shall restore, at no expense to the department and in general conformity with the contract for the bid item or bid items involved, all work completed under previous contracts that the contractor has damaged.
- (2) If the contractor procures or produces material from a pit, quarry, or deposit which is not an active commercial source or is not naturally submerged, the contractor shall do work as necessary and practical to shape, slope, and trim and drain the site, including associated haul roads and adjacent areas disturbed by the contractor's operations, so that it presents a stable, neat, trimmed appearance and that no water collects or stands therein. In special cases, the contractor may present a written request and written evidence that the owner of the property has a valid and practical plan for creating or enlarging a body of impounded water for soil or water conservation, irrigation, wild life propagation, agriculture, recreation, or

other purposes. The officials of local government and of other agencies must approve the plan with respect to area development. Ensure that the plan complies with the applicable ordinances or regulations. If the engineer deems the creation of a body of impounded water is not contrary to the public interest and will not create a public nuisance or hazard, the department may authorize the contractor to procure material below the elevation of drainability by surface water flow as described in a plan mutually agreed to by the contractor and the owner of the property and meeting with the engineer's approval.

- (3) The cost of final cleanup is incidental to the contract. The department will not allow separate or additional payment for final cleanup.

104.10 Cost Reduction Incentive

104.10.1 General

- (1) Subsection 104.10 specifies a 2-step process for contractors to follow in submitting a cost reduction incentive (CRI) for modifying the contract in order to reduce construction costs. The initial submittal is referred to as a CRI concept and the second submittal is a CRI proposal. The contractor and the department will equally share all savings generated to the contract due to a CRI as specified in [104.10.4.2\(1\)](#). The department encourages the contractor to submit CRI concepts for the following situations:
 - 1. The contractor generates the original cost savings idea and formulates it into a concept.
 - 2. The department generates the original cost savings idea and obtains the contractor's assistance to formulate the idea into a concept.
- (2) Follow the procedures specified in [104.10.2](#) for submitting a CRI concept. If the department determines that the CRI concept has merit, the department will encourage the contractor to submit a CRI proposal. Follow the procedures specified in [104.10.3](#) for submitting a CRI proposal.
- (3) The contractor may submit a CRI concept from a subcontractor. The department will reimburse the contractor. Subcontractors may not submit a CRI except through the contractor.
- (4) The contractor may submit a CRI concept only after the execution of the contract. Do not base bid prices on the anticipated approval of a CRI proposal. If the department rejects a CRI proposal, complete the contract as specified in the original terms or as otherwise modified.
- (5) The department will consider a CRI that changes but does not impair the essential functions or characteristics of the project. These functions or characteristics include, but are not limited to, appearance, service life, economy of operations, ease of maintenance, design and safety of structures and pavements, construction phasing or procedures, or other contract requirements.
- (6) The department will decide whether or not to approve a CRI. The department will bear no liability for causing a delay to the project in considering a CRI or for refusing to approve a CRI. The department may consider a noncompensable time extension as specified in [104.10.2\(3\)](#). The department will consider no contractor claims for additional costs related to the acceptance or rejection of a CRI, including loss of anticipated profits, or increased material or labor costs. The department will reimburse the contractor for the development costs of CRI proposals as specified in [104.10.4.1\(3\)](#).
- (7) A CRI, approved or not approved by the department, applies only to the contract for which the contractor submits it. Impose no restrictions on the CRI for its use or disclosure. The department has the right to use, duplicate, and disclose in whole or in part all data necessary for the utilization of the CRI. The department may use an accepted CRI or part of an accepted CRI on other projects without obligation to the contractor. This provision does not deny rights granted by law with respect to patented materials or processes. The department will not use this provision as the basis for rejecting the contractor's submittal of a CRI concept from past projects.
- (8) Continue to perform the work as the contract specifies until receipt of the engineer's written acceptance or rejection of the CRI Proposal.
- (9) Work produced under an approved CRI contract change order is subject to the provisions of [105.3.2](#) for nonconforming work.

104.10.2 Submittal and Review of a CRI Concept

- (1) Initially, submit a brief letter with graphics as necessary to the engineer to describe and illustrate the CRI concept. Estimate the overall CRI savings and the costs to develop the CRI proposal that are specified in [104.10.3](#). The engineer will use the contractor's estimate of the CRI proposal development costs as

specified in [104.10.4.1\(3\)](#). Indicate whether adequate time is available in the project schedule for submitting a complete CRI proposal and for the department's review before implementation.

- (2) The department will review the CRI concept and, within 5 business days of the contractor's initial submittal, inform the contractor in writing whether the CRI concept has merit and whether the contractor should submit it as a CRI proposal. The contractor and the department can mutually agree to extend this 5-day review requirement. The department will inform the contractor if a professional engineer should seal the CRI proposal. If the department informs the contractor to submit the CRI proposal, the department will share in the cost for developing the CRI proposal as specified in [104.10.4.1\(3\)](#).
- (3) If the department determines that the time for response indicated in the CRI concept letter is insufficient for review, the department may choose to evaluate the need for a noncompensable time extension to the contract. The department will base its evaluation on the additional time that the department needs for its review of the CRI proposal and the effect on the contractor's schedule caused by the added review time.
- (4) If the department has already taken action to implement revisions to the contract that are subsequently proposed in a CRI concept, the department may reject the CRI concept and revise the contract without obligation to the contractor.
- (5) The department may reject a CRI concept if it addresses a potential contract change situation as specified in [104.2](#).
- (6) The savings generated by the CRI must be sufficient to warrant its review and processing and offset the level of risk. The department will assess the risk of the CRI relative to departmental design policies and criteria for the project. The department may reject a CRI concept for the following reasons:
 1. It requires excessive time or costs for the contractor to develop the CRI proposal.
 2. It requires excessive time or costs for review, evaluation, investigation, or implementation.
 3. It introduces an inappropriate level of risk.

104.10.3 Submittal of the CRI Proposal

- (1) Within 10 business days after the department has determined that the CRI concept has merit, submit the CRI proposal. The contractor and department can mutually agree to extend this 10-day submittal requirement. Ensure that the CRI proposal includes sufficient data for the department to make an informed decision regarding the proposal and includes, at a minimum, the following information:
 1. A statement that the proposal is submitted as a CRI.
 2. A description of the difference between the existing contract and the proposed change and the advantages and disadvantages of each, which may include effects on service life, economy of operations, ease of maintenance, benefits to the traveling public, desired appearance, and safety.
 3. A complete set of plans and specifications showing the proposed revisions relative to the original contract features and requirements. Support the proposed revisions with design computations as necessary for a thorough and expeditious evaluation.
 4. A complete analysis indicating the final estimated costs and quantities to be replaced by the CRI compared to the new costs and quantities generated by the CRI. The department will use these costs as specified in [104.10.4.2\(1\)](#) to compute the proposed net savings.
 5. A statement specifying the time within which the department must make a decision.
 6. A statement detailing the effect the CRI will have on interim completion dates and the time for completing the contract.
 7. A description of a previous use or testing of the CRI and the conditions and results. If the contractor previously submitted the CRI on another department project, the contractor shall indicate the date, contract number, and action taken by the department.
 8. A detailed statement that indicates the costs for developing the CRI proposal and implementing the changes. The department will use these costs as the contractor's CRI development and implementation costs as specified in [104.10.4.1\(3\)](#) and [104.10.4.2\(1\)](#).
 9. Ensure that a registered professional engineer seals the CRI proposal if the department requires it as specified in [104.10.2\(2\)](#).
 10. If proposing design changes, the contractor may include with the additional information, results of field investigations and surveys, design computations, and field change sheets.

104.10.4 Acceptance, Rejection, and Payment

104.10.4.1 Acceptance, Rejection, and Payment of a CRI Proposal

- (1) Within 10 business days of the contractor's submission of the CRI proposal, the department will accept or reject the CRI proposal in writing. The contractor and the department can mutually agree to extend this 10-day review requirement. Provide requested additional information needed to evaluate the CRI proposal in a timely manner. The department may reject a CRI proposal for untimely submittal of additional information.
- (2) After accepting the CRI proposal, the department will execute a change order reimbursing the contractor for the cost of preparing the CRI proposal. The department will limit reimbursement to the contractor's estimate of the CRI proposal development costs provided in the CRI concept submittal. The change order will also state the conditions for the department's acceptance and which of the following the net savings will be based on:
 1. Agreed lump sum prices before the contractor performs the CRI.
 2. Agreed unit prices before the contractor performs the CRI in conjunction with quantities that the department will measure after the contractor completes the CRI.
- (3) If the department informs the contractor to submit a CRI proposal as specified in [104.10.2](#) and later rejects the CRI proposal, the department will execute a contract change order to adjust the contract for the contractor's development costs as listed in item 8 of [104.10.3\(1\)](#). The department will limit the contract revision amount to the contractor's estimate of the CRI proposal development costs provided in the CRI concept submittal. The contract change order will terminate the department's review of the CRI.
- (4) Rejection of a CRI proposal is not an allowable basis for a claim against the department for delay or for other costs.

104.10.4.2 Payment for the CRI Work

- (1) The department will pay for completed CRI work as specified for progress payments under [109.6](#). The department will pay for CRI's under the Cost Reduction Incentive administrative item. When all CRI costs are determined, the department will execute a contract change order that does the following:
 1. Adjusts the contract time, interim completion dates, or both.
 2. Pays the contractor for the unpaid balance of the CRI work.
 3. Pays the contractor 50 percent of the net savings resulting from the CRI, calculated as follows:

$$NS = CW - CRW - CC - DC$$

Where:

NS = Net Savings

CW = The cost of the work required by the original contract that is revised by the CRI. CW is computed at contract bid prices if applicable.

CRW = The cost of the revised work, computed at contract bid prices if applicable.

CC = The contractor's cost of developing the CRI proposal.

DC = The department's cost for investigating, evaluating, and implementing the CRI proposal.

- (2) The department is the sole judge of the acceptability of a CRI proposal and of the agreed net savings in construction costs from the adoption of all or part of the CRI proposal.

SECTION 105 CONTROL OF THE WORK

105.1 Engineer's Authority

- (1) The engineer decides all questions regarding:
 1. Interpretation of the contract.
 2. The quantity, quality, and acceptability of materials furnished and work performed.
 3. Rate of progress of the work.
 4. Payment, contract administration, and the acceptable fulfillment of the contract.
 5. Disputes.
 6. Mutual rights under the contract.
- (2) The engineer may suspend the work in writing for any reason at any time during the contract. Except as specified in [104.2.2.3](#) for engineer-ordered suspensions, the department will allow no additional payment or time extension due to a suspension of work.
- (3) The engineer will determine estimated quantities for progress payments as specified in [109.6](#).

105.2 Supplemental Plans and Drawings

- (1) Submit to the engineer supplements to the approved contract plans, shop drawings, and the computations necessary to control the work. Do not change the approved contract plans without the engineer's written authorization.
- (2) If sufficient detail is not provided on the structure plans produced by the department, submit to the engineer plans, shop drawings, and the computations required to successfully prosecute the work.
- (3) If required in the contract, submit plans for temporary structures, cribs, cofferdams, falsework, shoring, and form work. Ensure that these plans and accompanying drawings and computations are signed and sealed by a registered professional engineer.
- (4) Include a transmittal letter with each submittal made under 105.2. Indicate on shop drawings all deviations from the contract drawings and itemize these deviations in the transmittal letter. The department will file and may review these submittals. The department's review does not relieve the contractor of the responsibility for obtaining satisfactory results, for the accuracy of dimensions and details, or for conformity of these drawings with the contract. The contractor may begin work on associated items without the department's review.
- (5) Include the cost of furnishing all shop drawings in the unit price for one or more associated bid item.

105.3 Conformity with the Contract

105.3.1 General

- (1) Perform all work the contract specifies. Produce quality work within limits of precision reasonably expected of good construction. Produce work conforming to the lines, grades, cross-sections, dimensions, and material requirements the contract specifies or the engineer establishes. Monitor construction operations to identify potential unacceptable work as defined in [101.3](#). Promptly remove and replace, or otherwise correct, unacceptable work at no expense to the department.
- (2) The contractor may request a plan dimension change between US standard and SI metric dimensions for a portion of the work. The engineer will only consider this dimension change if the modified work is essentially equivalent to the specified work. The department will pay for this modified work as specified in item 4 of [109.1.1\(2\)](#). Do not proceed with the modified work without the engineer's written permission.
- (3) The contract may specify specific values with allowable tolerances, ranges, minimums, or maximums. Control operations to produce work that falls within the specified tolerance or range, falls above a specified minimum, or falls below a specified maximum. If the contract does not specify a tolerance, range, minimum, or maximum value, control operations to produce work conforming to the contract within accepted manufacturing or construction industry standards.
- (4) The contract may specify standard manufactured items such as fences, wire, plates, rolled shapes, pipe conduit, etc. If these items are identified by gauge, unit weight, section, dimensions, etc., these identifications are nominal weights or dimensions.

105.3.2 Nonconforming Work

105.3.2.1 Engineer-Accepted Nonconforming Work

- (1) If the work does not conform to the contract, the engineer will determine the circumstances under which that nonconforming work may be accepted and allowed to remain in place. The engineer will document the basis of acceptance and may execute a contract change order to adjust the contract unit prices for the nonconforming work. If the contract does not specify a price adjustment, the engineer will adjust the price.

105.3.2.2 Unacceptable Work

- (1) The engineer will issue a written order to remove and replace or otherwise correct nonconforming work that the engineer deems unacceptable, as defined in [101.3](#). If the contractor does not comply with the engineer's written order, the engineer may effect a remedy and deduct the cost from payments due the contractor.

105.3.2.3 Unauthorized Work

- (1) Unauthorized work is work performed as follows:
 1. Without the lines and grades being given.
 2. Beyond the lines and grades shown in the contract or provided by the engineer.
 3. Without the engineer's prior approval.
 4. After the inspector has temporarily suspended the work in writing as specified in [105.8](#).
 5. In violation of a written direction issued by the engineer.
- (2) The department may elect to not measure or pay for unauthorized work. The engineer may issue a written directive to remove unauthorized work at no expense to the department. If the contractor does not comply with the engineer's written directive, the engineer may remove unauthorized work and deduct the cost from payments due the contractor.

105.4 Coordination of the Contract Documents

- (1) All documents included under the definition of contract in [101.3](#) are essential parts of the contract. A requirement occurring in one is binding as though occurring in all. These documents provide for and describe the complete contract. These documents are available to the contractor at no cost.
- (2) During the progress of the work, the contractor may request that the engineer interpret or provide information relative to the contract.
- (3) If there is a discrepancy between documents, the governing order is as follows:
 1. Addenda.
 2. Special Provisions.
 3. Plans.
 4. Interim Supplemental Specifications.
 5. Supplemental Specifications.
 6. Standard Specifications.
- (4) If there is a discrepancy on a drawing, the dimensions shown on the drawing, unless obviously incorrect, govern over scaled dimensions. If there is a discrepancy in the plans, the typical sections or details govern over the standard detail drawings.
- (5) Neither the contractor nor the department may take advantage of an apparent error or omission in the contract. Inform the engineer immediately as specified in [104.3](#) upon discovering an error or omission. The engineer will offer an interpretation and make the necessary corrections.

105.5 Coordination with the Contractor

105.5.1 Contractor Obligations

- (1) Give the work the constant attention necessary to promote the progress of the work. Promptly supply the materials, tools, plant, equipment, labor, and incidental items required to perform the work.
- (2) Cooperate with the engineer and with third parties engaged upon or near the work. If the department grants a third party a permit to do utility work, the engineer may issue a change order directing the contractor to make or repair required roadway openings. The department will pay the contractor as specified in [104.2](#) for extra work.

- (3) Maintain one copy each of the plans and specifications at the site of work at all times. The engineer will supply the contractor with copies of the contract. If the department has electronically computed estimated grading quantities, the department will furnish that information to the contractor upon request.
- (4) Supervise and direct the work competently and efficiently. Devote the attention and apply the expertise necessary to perform the work as the contract specifies. Monitor the work in progress to ensure that the work conforms to the contract. The contractor is solely responsible for the means, methods, techniques, sequences, and procedures of construction. The contractor is not responsible for the negligence of others in the design or specification of specific means, methods, techniques, sequences, or procedures of construction described in and expressly required by the contract.
- (5) Employ a competent superintendent or designate a representative capable of reading and understanding the contract and experienced in the type of work being performed. The superintendent or designated representative shall be the authorized agent of the contractor and shall have full authority to execute the engineer's directions or instructions without delay. Ensure that the superintendent or designated representative is on the project or accessible to the engineer during all hours of each work day. Notify the engineer promptly when replacing the superintendent or designated representative.

105.5.2 Cooperation Between Contractors

- (1) The department may, at any time, contract for or perform other work on or near the work covered by the contract. Cooperate with other contractors engaged upon or near the work.
- (2) The contractor shall, or the engineer may, direct the contractor to:
 - 1. Schedule and conduct the work to avoid interference with the operations of other contractors engaged upon or near the work.
 - 2. Perform the work in the proper sequence in relation to that of other work in the area.
 - 3. Join the work to that of others in a manner consistent with accepted manufacturing or construction industry practices.
 - 4. Conduct operations and maintain the work so that adequate drainage is provided at all times.
- (3) The contractor is responsible for damage done by the contractor or the contractor's agents to work performed by other contractors. The engineer will resolve disputes between 2 or more contractors, engaged upon or near the work, regarding the rights of each under their respective contracts.

105.6 Construction Staking

105.6.1 General

- (1) The department is responsible for errors or discrepancies found in previous department surveys, plans, specifications, special provisions, or work constructed under other department contracts. The department will pay for further studies and redesign required due to these errors or discrepancies.
- (2) The department will furnish and set original horizontal and vertical control points. Prosecute the work using these points for field control. Maintain all required stakes and marks. The department will deduct, from payment due the contractor, \$100 per hour for the cost of the work required to replace engineer's stakes or marks destroyed or disturbed. The department will administer this deduction under the Replacing Construction Stakes administrative item.
- (3) The engineer and contractor shall agree on the meaning of all stakes, measurements, and marks before the contractor begins work.

105.6.2 Department Performed Staking

- (1) The department will perform the staking required to lay out and construct the work except for the staking required under [section 650](#) for the individual construction staking bid items the contract includes.
- (2) The department is responsible for the accuracy of lines, slopes, and grades it provides under 105.6.2.
- (3) During construction, the contractor may submit requests for staking to the engineer. The department is responsible for staking delays only if the engineer receives that request at least 72 hours before related work begins.

105.6.3 Contractor Performed Staking

- (1) In addition to department provided staking, furnish and set the following
 - 1. Additional staking or markings that might be needed to support the contractor's specific method of operations.

2. Staking required under [section 650](#) to lay out and construct the work for the individual construction staking bid items the contract includes.
- (2) The contractor is responsible for the accuracy of lines, slopes, and grades the contractor provides. Construct the work conforming to the lines, grades, cross sections, and dimensions the contract specifies or the engineer establishes.
- (3) Notify the engineer immediately when finding errors or discrepancies in previous surveys, plans, specifications, special provisions, or work constructed under other contracts. Suspend related operations until the engineer gives approval to proceed.
- (4) The engineer may check the control of work, as established by the contractor, at any time. The engineer will provide the results of these checks to the contractor, but by doing so in no way relieves the contractor of the responsibility for the accuracy of their layout work.
- (5) Correct or replace deficient layout and construction work resulting from:
 1. Inaccuracies in the contractor's staking operations.
 2. Not reporting inaccuracies found in work done by the department or by others.
- (6) If, due to the inaccuracies in 105.6.3(5), the department is required to make further studies, redesign, or both, the department will deduct all expenses incurred from the payment due the contractor.

105.7 Authority and Duties of Project Engineer

- (1) As the engineer's direct representative, the project engineer has immediate charge of the engineering details of each construction project. The project engineer is responsible for field administration of the project. The engineer authorizes the project engineer to reject defective material and to suspend all work being improperly performed. The engineer may delegate additional authority, granted under [105.1](#), to the project engineer.

105.8 Authority and Duties of Inspectors

- (1) As the engineer's authorized representatives, inspectors may inspect all work done and all materials furnished.
- (2) The department authorizes inspectors to:
 1. Call the contractor's attention to work or materials that do not conform to the contract.
 2. Reject materials until the engineer is notified and decides all questions at issue.
 3. Temporarily suspend work, in writing, until the engineer is notified and decides all questions at issue.
- (3) The department does not authorize inspectors to do the following unless specifically delegated by the engineer:
 1. Revoke, alter, or waive any requirements of the contract.
 2. Approve or accept any portion of the completed project.
 3. Act as foreperson or perform other duties for the contractor.
- (4) The engineer may delegate additional authority to the inspector.

105.9 Inspecting Work

- (1) The engineer may inspect, at any time, all materials and all parts of the work. This inspection may include the preparation, fabrication, or manufacture of materials or components on or off the project site. Allow the engineer safe access to all parts of the work. Furnish the information and assistance needed to make a complete inspection.
- (2) If requested by the engineer, uncover or remove portions of finished work for inspection. After inspection, restore that work to the contract requirements. If the department finds the work acceptable, the department will pay for uncovering, removing, and restoring that work as extra work. If the department finds the work unacceptable, the contractor shall pay for uncovering, removing, and restoring that work.
- (3) Failure to reject defective work or materials does not prevent the department from rejecting defective work once it is discovered.

105.10 (Vacant)

105.11 Inspection and Acceptance

105.11.1 Partial Acceptance

- (1) Upon completion of a portion of the work, the contractor may request partial acceptance of that work. The engineer will conduct an inspection to determine if the contractor has satisfactorily completed operations in that area. Within 5 business days, the engineer will grant, in writing, partial acceptance for that portion of the work or reject the contractor's request. If the engineer grants partial acceptance, the engineer will, designate in writing, what portion of the work is partially accepted and the effective date for that partial acceptance.
- (2) Partial acceptance will relieve the contractor of maintenance responsibility for the designated portion of the work. By relieving the contractor of maintenance, the department does not relieve the contractor of responsibility for defective work or damages caused by the contractor's operations. Do not construe partial acceptance to be final inspection, final acceptance of any part of the work, or a waiver of any legal rights specified under [107.16](#).

105.11.2 Final Acceptance

105.11.2.1 Inspection

- (1) Notify the engineer when the project is substantially complete as defined in [105.11.2.3](#). As soon as it is practical, the engineer will inspect the work and categorize it as one of the following:
 1. Unacceptable or not complete.
 2. Substantially complete.
 3. Complete and accepted as final.

105.11.2.2 Unacceptable or Not Complete

- (1) The engineer will identify, in writing, work that is unacceptable or not complete. Immediately correct or complete that work. The engineer will assess contract time until the work is corrected or completed.
- (2) Proceed as specified in [105.11.2.1](#) until the work is complete and accepted as final.

105.11.2.3 Substantially Complete

- (1) The project is substantially complete and the engineer will no longer assess contract time if the contractor has completed all contract bid items and change order work, except punch-list and cleanup work. As applicable, the following must have occurred:
 1. All lanes of traffic are open on a finished surface.
 2. All signage and traffic control devices are in place and operating.
 3. All drainage, erosion control, excavation, and embankments are completed.
 4. All safety appurtenances are completed.
- (2) The engineer will identify in writing the punch-list, required cleanup work as specified in [104.9](#), and required document submittals. Immediately correct or complete that work. The engineer may restart assessing contract time if the contractor does not complete the punch-list and cleanup work within 5 business days of receiving the engineer's written notice. The engineer and contractor may mutually agree to extend this 5-day requirement.
- (3) Proceed as specified in [105.11.2.1](#) until the work is complete and accepted as final.

105.11.2.4 Complete and Accepted as Final

- (1) When the engineer determines that the project is complete and accepted as final, the engineer will give the contractor written notice of final acceptance effective on the date of the final inspection. If the contractor has not submitted the required documents or materials tests are not complete at the time of the final inspection, the engineer will grant conditional acceptance subject to receipt of the required documents and satisfactory test reports. Failure to discover defective work or materials at the time of final inspection does not prevent the department from rejecting defective work once it is discovered. The department may revoke its final acceptance if the department discovers defective work after it has accepted the work.

105.12 (Vacant)

105.13 Claims Process for Unresolved Changes

105.13.1 Notice of Claim

- (1) If the contractor has followed the procedures for revising the contract specified in [104.2](#) and provided the notification specified in [104.3](#), but still disagrees with the engineer, the contractor may pursue the issue as a claim. File a notice of claim with the engineer concerning the disagreement within 10 business days of receiving the engineer's 5-day written response described in [104.3.6](#). Update the previously submitted information if something has changed that may affect the engineer's previous decision.
- (2) The engineer may deny the applicable portion of a claim if the contractor does not do the following:
 1. File the notice of claim within 10 business days as specified in 105.13.1(1).
 2. Give the engineer sufficient access to keep a record of the actual labor, materials, and equipment used to perform the claimed work.
- (3) Upon filing the notice of claim, maintain records as specified for force account statements in [109.4.5.1\(3\)](#). Unless the engineer issues a suspension, the contractor shall continue to perform the disputed work. The department will continue to make progress payments to the contractor as specified in [109.6](#).

105.13.2 Submission of Claim

- (1) Submit the claim to the project engineer as promptly as possible following the submission of the Notice of Claim, but in no event later than 60 calendar days after final acceptance of the project as specified in [105.11.2](#). If the contractor does not submit the claim within those 60 calendar days, the department may deny the claim. The contractor and the project engineer can mutually agree to extend this 60-day submittal requirement.

105.13.3 Content of Claim

- (1) Include the following 5 items in the claim.
 1. A concise description of the claim.
 2. A clear contractual basis for the claim. This should include reference to [104.2](#) on revisions to the contract and as appropriate, specific reference to contract language regarding the bid items in question.
 3. Other facts the contractor relies on to support the claim.
 4. A concise statement of the circumstances surrounding the claim and reasons why the department should pay the claim. Explain how the claimed work is a change to the contract work.
 5. A complete breakdown of the costs used to compile the claim. Include copies of all blue book equipment rental rate sheets used, with the applicable number highlighted.
- (2) The department may refer the claimant of a false claim to the appropriate authority for criminal prosecution. Certify the claim using the following form:

The undersigned is duly authorized to certify this claim on behalf of (the contractor).

(The contractor) certifies that this claim is made in good faith, that the supporting data are accurate and complete to the best of (the contractor's) knowledge and belief, and that the amount requested accurately reflects the contract adjustment for which (the contractor) believes that the department is liable.

(THE CONTRACTOR)

By: _____

(Name and Title)

Date of Execution: _____

105.13.4 Review by the District

- (1) In the initial review phase, the contractor and the district will have up to 30 calendar days, from the contractor's submission of the claim, for the contractor to submit all additional information required and for the district to review the claim and conduct all meetings. The district may request, in writing, that the contractor submit additional information related to the claim. The contractor shall submit that additional information, or notify the district in writing to base its decision on the information previously submitted. Either party may request a meeting to present their views. Before the meeting, the district will distribute written ground rules for the meeting to both parties.
- (2) The contractor and the district can mutually agree to extend this 30-day initial review period. Upon completion of the initial review phase, the district will notify the contractor in writing that it has begun the decision phase.
- (3) In the decision phase, the district will have up to 30 calendar days to render a written decision. The district will consider both parties' written and oral submissions and may consider other relevant information in the project records. The district and contractor can mutually agree to extend this 30-day decision period. The district will provide the following in its decision:
 1. A concise description of the claim.
 2. A clear, contractual basis for its decision that includes a reference to [104.2](#) on revisions to the contract and as appropriate, specific reference to language regarding the bid items in question.
 3. Other facts the district relies on to support its decision.
 4. A concise statement of the circumstances surrounding the claim and reasons for its decision. If the district rejects the claim in whole or in part, the district will explain why the claimed work is not a change to the contract work.
 5. The amount of money or other relief, if any, the district will grant the contractor.
- (4) In the appeal phase, the contractor will have up to 30 calendar days from the date of the district's decision to appeal to the bureau. If the contractor does not file a written appeal within those 30 days, the district's decision is final. If the district does not render a decision within the 30 calendar days specified in 105.13.4(3), the claim will be automatically appealed to the bureau for review as if the district had rejected the contractor's claim.
- (5) In lieu of review by the bureau, the department and contractor can mutually agree to an alternate dispute resolution process.

105.13.5 Review by the Bureau

- (1) If the contractor appeals the district's decision or if the district does not act on the contractor's claim, the bureau will review the claim. The district will forward the claim to the bureau and give the bureau all documents and evidence regarding the claim previously submitted to the district. At this point or a subsequent point in the bureau's review, the department may waive the bureau's review and refer the claim directly to the review panel.
- (2) In the initial review phase, the contractor and the bureau will have up to 30 calendar days, from the date of the appeal, to submit all additional information required to review the claim and to conduct all meetings. The bureau may request, in writing, that the contractor submit additional information related to the claim. The contractor shall submit that additional information, or notify the bureau in writing to base its decision on the information previously submitted. Either party may request a meeting to present their views. Before the meeting, the bureau will distribute written ground rules for the meeting to both parties.
- (3) The contractor and the bureau can mutually agree to extend this 30-day initial review period. Upon completion of the initial review phase, the bureau will notify the contractor in writing that it has begun the decision phase.
- (4) In the decision phase, the bureau will have up to 30 calendar days to render a written decision. The bureau will consider both parties' written and oral submissions, and may consider other relevant information in the project records. The bureau may affirm, overrule, or modify, in whole or in part, the district's decision. The bureau and contractor can mutually agree to extend this 30-day decision period.
- (5) In the appeal phase, the contractor will have up to 30 calendar days, from the date of the bureau's decision, to appeal to the review panel. If the contractor does not file a written appeal within those 30 days, the bureau's decision is final. If the bureau does not render a decision within the 30-day period specified in 105.13.5(4), the claim will be automatically appealed to the review panel for review as if the bureau had rejected the contractor's claim.

- (6) In lieu of review by the review panel, the department and contractor can mutually agree to an alternate dispute resolution process.

105.13.6 Review Panel

- (1) If the contractor appeals the bureau's decision, the bureau waives its review, or the bureau does not act on the contractor's claim, the review panel will review the claim. The bureau will forward the claim to the review panel. The district will give the review panel all documents and evidence regarding the claim previously given to the bureau. The review panel may request that the contractor and the district submit additional evidence or documents related to the claim. The review panel will consider both parties' written and oral submissions, and may consider other relevant information in the project records.
- (2) The review panel will conduct a hearing with the contractor and the district. Before the hearing, the department will distribute written ground rules for the hearing to both parties.
- (3) The review panel may affirm, overrule, or modify, in whole or in part, the district's decision or the bureau's decision. The review panel will render a decision within 60 calendar days from the date of the appeal. Within 14 calendar days of the review panel's decision, the contractor shall accept or reject their decision in writing. If the contractor does not respond within those 14 calendar days, the review panel's decision is final. The review panel and contractor can mutually agree to extend this 14-day response period.
- (4) If the contractor disagrees with the review panel's decision, the contractor may initiate a legal action pursuant to state statutes.

SECTION 106 CONTROL OF MATERIALS

106.1 General

- (1) Provide materials conforming to the contract. Use materials the contract specifies unless the engineer authorizes substitutes under [108.8](#). Monitor construction operations to identify potential nonconforming materials and prevent their incorporation into the work.
- (2) All materials are subject to the engineer's approval before incorporation into the work. The engineer may inspect or test all materials at any time during their preparation, storage, and use. Notify the engineer of the proposed source of materials before delivering those materials to the project site. If the engineer requests, provide samples of material and access to facilities that the engineer needs to assess the acceptability of all materials. The department will, on request, share with the contractor available information on a source or material.
- (3) For fabricated components, the materials and the fabricator are subject to the department's approval before delivery of those components to the project site. The engineer may require the contractor to obtain components from another department-approved source if the department determines that a fabricator's product does not conform to the contract.
- (4) Do not incorporate materials into the work until the engineer approves those materials. However, the contractor may request permission to incorporate materials not already approved. The engineer will grant this permission only if the contractor can provide convincing evidence that the engineer will subsequently find those materials conforming. Incorporation of materials before approval is at the contractor's risk and permission to do so does not imply that the department will subsequently approve those materials.

106.2 Supply Source and Quality

106.2.1 Waste Materials

- (1) The department encourages the contractor to incorporate material from the WDNR list of special wastes, cited in section 895.58 of the Wisconsin statutes, into the work. The department encourages use of the maximum amount of special waste consistent with the contract and standard engineering practice.
- (2) For materials used during construction but not incorporated into the work, use multiple-use or biodegradable products, if it is practical, to minimize the amount of solid waste generated during construction operations.

106.2.2 Preference for American-Made Materials

- (1) If all other factors are substantially equal, furnish materials manufactured to the greatest extent in the United States as provided in Wisconsin statute 16.754.

106.2.3 Product Substitution

- (1) Provide US standard or SI metric system products as the contract specifies. The department will allow substitutions for the specified product if both of the following conditions are met:
 1. The substitute product is made from the same material as the original product, and complies with the corresponding specification requirements for the substitute product.
 2. Dimensions of the substitute product are essentially equal to dimensions of the original product. The department will allow established manufacturing and fabrication tolerances unless the contract specifies absolute maximum or minimum dimensions.
- (2) Certify to the engineer, in writing, that the substitute product complies with the requirements of 106.2.3(1). The contractor shall not furnish the substitute product until the engineer approves the substitution in writing. The department will pay for the installed quantity of the substitute product at the contract price for the original product.

106.2.4 Conditional Approval of Materials

- (1) The department may require, by contract or at the discretion of the engineer, inspection of materials at the point of manufacture or source of supply. The department may conditionally approve materials found to be in compliance at the point of manufacture or source of supply.
- (2) If inspection is required at a manufacturing or source plant, do the following:
 1. Provide the engineer with the results of relevant tests the contractor or producer performs.
 2. Cooperate with and assist the engineer.

3. Secure for the engineer full access to parts of the plant used to manufacture or produce materials when contract work is in progress.
 4. If the engineer requires, secure acceptable working space in or near the plant.
 5. Provide advance notice of production schedules as the engineer requests.
 6. Provide and maintain adequate safety measures at the plant for the engineer.
- (3) The engineer may prohibit project site delivery of materials requiring inspection at the point of manufacture or source of supply until the engineer grants conditional approval.

106.3 Approval of Materials

106.3.1 General

- (1) The department will approve materials or components demonstrated to conform to the contract. The department will base its approval on conformance with the contract as close as it is practical to the point of incorporation into the work. The department approves materials based primarily on the engineer's tests, tests the contractor performs under the quality management program, or tests the manufacturer performs and certifies. For materials conditionally approved at the point of manufacture or source of supply, the engineer may:
1. Retest or re-inspect materials after delivery to the project site.
 2. Reject material subsequently found to be non-complying.
- (2) The department may augment test results with documented performance history or inspection of processing, storage, handling, and construction operations. If the contract requires or the engineer requests, the contractor shall provide written documentation of the origin, composition, or process of manufacture of a material.
- (3) The department's approval of materials or components does not constitute acceptance of the work incorporating those materials or components.

106.3.2 Approved Product Lists

- (1) The department maintains product acceptability lists and other lists of approved products and approved manufacturers or suppliers. The department includes products on these lists based on the results of prior testing and a satisfactory performance history on departmental projects. The department may retest or re-inspect products after delivery to the project site to verify that they conform to the contract. A product is nonconforming if verification test results indicate the product does not meet the requirements for inclusion in the department's approved products list.

106.3.3 Approval by Certification

- (1) For manufactured products or assemblies, the engineer may accept a certified report of test or analysis, or a certificate of compliance instead of performing tests on samples. If not designated in the contract for the specific material involved, the engineer will determine the form and distribution of the required documents. Submit the number of copies of each document that the engineer specifies.
- (2) For testing documented by certificate, all sampling and testing procedures and testing facilities are subject to the review and approval of the department. The department may sample and test products to verify the certified test results. Provide samples as the department directs.
- (3) Create a file of manufacturers' certificates of compliance for the contract. Maintain these certifications on file for a period of 5 years after completing the contract work. If the department requests, provide the requested certification within 5 business days.
- (4) Products are nonconforming if one or more of the following apply:
1. Certifications are not provided within the specified time or in the specified form.
 2. Certified properties do not conform to the contract.
 3. Verification test results indicate the products do not conform to the contract.

106.3.4 Approval By Sampling and Testing

106.3.4.1 General

- (1) Except as specifically provided in the contract, the engineer will determine sampling and testing frequencies and sample locations, both on and off the project site.

- (2) The department will determine the sampling and testing methodology using the following order of precedence. The department will:
 1. Use specific methods the contract references.
 2. Use CMM specified methods if the contract does not reference specific methods.
 3. Use department standard practices if the contract does not reference specific methods and the CMM does not specify a method.
- (3) The department will maintain copies of all AASHTO and ASTM sampling and testing standards referenced in the contract. Contractors, bidders, or the suppliers of materials may examine those standards at the department's central office in Madison. The department will also make available for examination all other standards referenced in the contract as well as the department's sampling and testing standard practices.
- (4) All department and contractor personnel engaged in sampling and testing of materials to be incorporated into the work must be qualified under a department-accepted program for the specific tasks they are performing.
- (5) All laboratory facilities employed in sampling and testing of materials to be incorporated into the work must be qualified, for the specific tests they are performing, by the department under its laboratory qualification program.

106.3.4.2 Department's Material Testing Program

- (1) Furnish without charge all samples that the engineer requires and provide the facilities and staff required for collecting and forwarding them to the department. The department will, on request, share with the contractor test results obtained on contractor-furnished samples of materials.

106.3.4.3 Department's Quality Management Program

106.3.4.3.1 General

- (1) If QMP provisions are specified in the contract, the department will base approval of the covered materials on a combination of the results of the following:
 1. Contractor quality control testing required under the contract.
 2. Optional contractor assurance testing.
 3. Departmental verification testing.
 4. Inspections of the materials production, storage, handling, and construction processes.
 5. Dispute resolution procedures.
- (2) Required sampling and testing methodologies and documentation procedures are specified in the department's QMP guide/procedure manual.
- (3) If disputed, approval of materials and components, as well as the subsequent acceptance of the work incorporating those materials or components, is subject to review under a specified dispute resolution process.

106.3.4.3.2 Technician Certification

- (1) If required in the individual QMP specifications, both the department's and the contractor's sampling and testing personnel must be certified under the department's highway technician certification program.

106.3.4.3.3 Contractor Quality Control

- (1) Provide the qualified quality control personnel required in the contract. Conduct process control inspections, sampling and testing, documentation, and process adjustments required to ensure that the materials incorporated into the work conform to the contract.

106.3.4.3.4 Contractor Assurance

- (1) Conduct additional optional testing, as allowed under individual quality management program specifications, to help limit contractor liability for nonconforming materials.

106.3.4.3.5 Documentation

- (1) If the contract requires, provide: records, control charts, and a quality control plan documenting the reliable production of conforming materials and components.

106.3.4.3.6 Department Verification

- (1) The department will periodically conduct independent verification tests to validate the quality of the materials incorporated into the work.

106.3.4.3.7 Independent Assurance

- (1) The department may evaluate all personnel engaged in sampling and testing of materials to be incorporated into the work. The department will base its evaluation on observation of procedures, review of control charts and other required documentation, and split-sample testing.
- (2) The department may evaluate equipment the contractor uses to sample and test materials. The department will base its evaluation on visual inspection, calibration checks, or split sample or proficiency testing.

106.3.4.3.8 Dispute Resolution

- (1) For potentially nonconforming materials, the contractor and department will thoroughly investigate substantive discrepancies in their respective test results. If this investigation does not identify the cause of those discrepancies, the department or the contractor may invoke the applicable quality management program dispute resolution provisions. The dispute resolution team will use these procedures to determine the acceptability of, disposition of, and payment for the affected material

106.4 Storing and Handling Materials

- (1) Store and handle materials to preserve their quality and fitness for the work. Provide easy access for the department to inspect and test stored materials. Even if approved before storage, the engineer may find materials nonconforming based on re-inspection before incorporation into the work.
- (2) Provide the engineer with the storage locations of materials intended for the work. If the engineer allows, the contractor may store materials on portions of the right-of-way not required for public travel. Provide additional off-site storage space at no additional expense to the department. Off-site storage areas for approved or conditionally approved materials are subject to the department's inspection and approval.

106.5 Nonconforming Materials

- (1) For nonconforming materials identified before incorporation into the work, the engineer will do one of the following:
 - 1. Reject those materials. Unless the engineer allows otherwise, the contractor shall remove rejected materials from the project site at no cost to the department. The engineer may allow the contractor to correct rejected materials. The contractor shall obtain the engineer's approval for previously rejected, but subsequently corrected, materials before incorporating those materials into the work.
 - 2. Approve those materials subject to reduced payment. The engineer will determine the circumstances under which those nonconforming materials may be approved and allowed to remain in place. The engineer will document the basis of approval and may execute a contract change order to adjust the contract unit prices for the nonconforming materials. If the contract does not specify a price adjustment, the engineer will adjust the price.
- (2) For materials incorporated in the work and subsequently found to be nonconforming, the engineer will do one of the following:
 - 1. Reject those materials subject to the provisions of [105.3.2.2](#) for unacceptable work
 - 2. Approve those materials and adjust the contract price as provided in [105.3.2.1](#) for engineer accepted nonconforming work.

SECTION 107 LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

107.1 Laws to be Observed

- (1) At all times, observe and comply with all applicable federal and state laws and administrative rules, codes, local laws, ordinances, and regulations that affect the conduct of the work, and applicable orders or decrees of bodies or tribunals having jurisdiction or authority over the work. The department will consider no plea of misunderstanding or ignorance thereof. The contractor shall indemnify and save harmless the state and all of its officers, agents, and employees against any claim or liability arising from or based on the violation of any applicable law, ordinance, regulation, order, or decree, whether by the contractor or the contractor's employees, subcontractors, or agents.
- (2) Comply with all applicable federal, state, and local health official rules and regulations governing safety, health, and sanitation. Provide all necessary safeguards, safety devices, and protective equipment. Take all other actions that are reasonably necessary to protect the life and health of employees on the project and the safety of the public.

107.2 Haul Road Notification

- (1) Notify the engineer in writing at least 3 business days before hauling project materials over a public road or street not a part of the state trunk highway system. The department will subsequently survey the existing condition of that haul route to establish a baseline for assessing damage that the contractor's hauling operations might cause.

107.3 Permits and Licensing

- (1) Procure all permits and licenses, pay all charges and fees, and give all notices necessary to perform the work. The contractor shall comply with all permit requirements whether the permit is issued to the contractor, the state, or the maintaining authority.

107.4 Patented Devices, Materials, and Processes

- (1) Include in the bid prices royalties and costs arising from patents, trademarks, and copyrights. Before using a design, device, material, or process covered by letters, patents, or copyrights, provide for its use by suitable legal agreement with the patentee or owners. Provide proof of this agreement with the engineer if necessary. The contractor and the contractor's surety shall provide indemnification from all claims for infringement of patents, trademarks, or copyrights as specified in [107.12](#).

107.5 Labor Compliance

- (1) Comply with all contract labor compliance provisions and take responsibility for subcontractor and lower tier subcontractor compliance. Submit department-requested documentation within the time the department specifies in a written notice. Resolve all labor compliance issues within 90 days after receiving the department's first written notice. The department and the contractor can mutually agree to extend this 90-day requirement. Actively pursue resolution of contract labor compliance issues and attend all contract labor compliance meetings and hearings.

107.6 Federal Participation

- (1) If the federal government participates in the cost of the contract:
 1. The work is subject to the inspection and approval of the proper officials of the federal government.
 2. The work shall conform to the applicable federal statutes, rules, and regulations.
- (2) The federal government is not a party to the contract and will not interfere with the rights of either party under the contract.

107.7 (Vacant)

107.8 Public Convenience and Safety

- (1) Maintain the safety of the traveling public and control traffic using barricades, warning signs, and flaggers as specified in [104.6.1](#).
- (2) If the contract provides that the road or portions of the road are closed to public traffic during construction, the engineer may direct or authorize the contractor to open sections of the road to public traffic before the work is completed as specified in [104.6.5](#).

- (3) When hauling materials on public roads or streets, equip vehicles subject to spillage with tailgates and adequate sideboards. Use covers and other protective devices necessary to prevent spillage. The contractor is responsible for removing spillage from the entire area within the right-of-way of the haul route. Immediately remove spillage that interferes with or creates a hazard for traffic.
- (4) Notify the responsible fire department and police department at least 24 hours before closing a road, street, or highway.
- (5) If excavating adjacent to a building or wall, give the property owner sufficient written notice of the impending excavation. The contractor and the contractor's surety shall hold the state and the municipality in which the work is done harmless from damage to the building or wall.
- (6) Check for and comply with local ordinances governing the hours for operation of construction equipment. Obtain the engineer's written approval for operations from 10:00 P.M. until 6:00 A.M.

107.9 Contractor's Use of the Highway Right-of-Way

- (1) The department has sole authority to grant the contractor permission to occupy and use the right-of-way. All activity within the right-of-way is subject to the engineer's approval.
- (2) If the engineer allows, the contractor may store materials and equipment or place the plant on portions of the right-of-way not required for public travel. Do not park vehicles or equipment not in immediate use, store materials, or create obstructions that may unduly distract motorists traveling through construction areas. Minimize hazards to motorists, pedestrians, and workers.

107.10 Use of Explosives

- (1) Observe the utmost care when using explosives so as not to endanger life and property. Use, store, and handle explosives and highly inflammable materials conforming to applicable federal, state, and local laws and regulations including the rules of the Wisconsin department of commerce.

107.11 Protecting and Restoring Property

107.11.1 General

- (1) Notify, in writing, all public and private property owners whose property interferes with the work. Advise them of the nature of the interference, and arrange with them for the disposition of the property. Upon request, furnish the engineer with copies of all notifications and final agreements.
- (2) Use every reasonable precaution to prevent damage to all property including poles, trees, shrubbery, crops, and fences adjacent to or interfering with the work; all overhead structures including wires, cables, etc.; and all underground structures including water or gas shut-off boxes, water meters, pipes, conduits, etc.; within or outside the right-of-way.
- (3) Assume liability for all damage to public or private property resulting from contractor operations, defective work or materials, or non-execution of the contract. Restore property, to a condition similar or equal to that existing before causing the damage, as the engineer directs or in a manner acceptable to the property owner. If the contractor fails to restore property within a reasonable time, the department may, upon 48 hours written notice, restore that property as the engineer deems necessary. The department will deduct restoration costs from payments due the contractor under the contract.

107.11.2 Freeway Traffic Management Systems

- (1) If the contractor's operations interrupt FTMS service, notify the engineer immediately and take the action required to restore service within 24 hours. Repair damaged facilities to the condition existing before interruption. If the contractor does not restore service within 24 hours, the department may restore service and deduct restoration costs from payments due the contractor under the contract.

107.11.3 Property Marks

- (1) Protect and carefully preserve all known property and survey marks and land monuments, and notify the engineer of the nature and location of these markers. Do not disturb or destroy markers until the engineer has arranged for their referencing or perpetuation.

107.11.4 Burning

- (1) Do not start fires without first securing the necessary permits and the approval of the local authority having jurisdiction, or the county forest ranger, or the WDNR bureau of forestry. Comply with applicable requirements of the WDNR's air pollution control rules, including the limitations on open burning. When burning brush, stumps, or rubbish, take care not to damage standing trees, shrubs, or other property. Assume liability for all damage caused by fires.

107.12 Responsibility for Damage and Tort Claims

- (1) The contractor and the contractor's insurer shall defend, indemnify, and save harmless the following entities:
 1. The state, its officers, agents, and employees. In this context, agents exclude consulting firms, Wisconsin counties and municipalities, and their respective officers and employees.
 2. The county, town, or municipality in which the improvement is made, each of them separately or jointly, and their officers, agents, and employees.
- (2) Defend, indemnify, and save harmless all entities in 107.12(1) from all suits, actions, or claims of any character brought because of one or more of the following:
 1. Injuries or damages received or sustained by a person, persons, or property resulting from the contractor's operations.
 2. Neglect in safeguarding the work.
 3. Use of unacceptable materials in constructing the work.
 4. Acts or omissions, neglect, or misconduct of the contractor.
 5. Claims or amounts recovered for an infringement by the contractor of patent, trademark, or copyright.
 6. Claims or amounts arising or recovered under the workers compensation act, relating to the contractor's employees.
 7. The contractor's noncompliance with a law, ordinance, order, or decree relating to the contract.
- (3) The department may retain payments due the contractor in amounts sufficient to cover the cost of suits, actions, or claims caused by the reasons specified in 107.12(2). The department will not release this retainage until the contractor furnishes satisfactory evidence of one of the following:
 1. The contractor is adequately protected from the suits, actions, or claims with the insurance coverages specified in [107.26](#) or other insurance.
 2. The parties have settled the suits, actions, or claims.
- (4) The state is not liable to the contractor for damages or delays resulting from third party work, except for excusable delays as specified in [108.10.2](#) and [108.10.3](#). The state also is exempt from liability to the contractor for damages or delays resulting from injunctions or other restraining orders obtained by third parties except where the damage or delay is a direct result of an injunction or restraining order obtained by a citizen's action alleging violations of 42 U.S.C. 4331-4332, 23 U.S.C. 138, or public law 91-646.

107.13 Third Party Beneficiary

- (1) This contract does not create anyone as a third party beneficiary. This contract does not authorize non-parties to the contract to maintain actions for damages under the contract.

107.14 Contractor's Responsibility for Work

- (1) Until the engineer accepts the work as specified in [105.11](#) the contractor shall maintain charge and care of the work except as specified in [104.6](#). Within 107.14, the term "work" is redefined to mean "the work product that is completed in its final position and is incorporated in the project." Protect all of the work against injury or damage caused by the action of the elements, or from any other cause, whether arising from the execution or non-execution of the work. Rebuild, repair, restore, and make good all injuries or damages to any portion of the work occasioned by the above causes at no additional cost to the department.
- (2) The contractor shall not bear the expense for damage to the work caused by abnormal and unforeseeable occurrences beyond the control of, and without the fault or negligence of, the contractor. These abnormal and unforeseeable occurrences include but are not limited to the following:
 1. Cataclysmic phenomena of nature.
 2. Acts of the public enemy.
 3. Acts of government authorities.
- (3) Before suspending the work, take the necessary precautions to prevent damage to the project, prevent traffic accidents, and provide for normal drainage. Erect necessary temporary barricades, signs, or other facilities at no expense to the department except as specified in [104.6](#).
- (4) The contractor is responsible for all damages to equipment and supplies regardless of the circumstances.

107.15 Personal Liability of Public Officials

- (1) In carrying out contract provisions, or in exercising power or authority granted to them by or within the scope of the contract, the department, the engineer, or their authorized representatives have no liability, either personally or as officials of the state. In all of these matters, they act solely as agents and representatives of the state. The contractor waives all rights of action against the department, its agents, or employees.

107.16 No Waiver of Legal Rights

- (1) The department may correct a measure, estimate, or certificate at any time before or after final acceptance. The department may recover from the contractor, surety, or both, overpayments upheld for a breach (failure to fulfill contract obligations). A waiver on the part of the department of a breach of a part of the contract is not a waiver of another or subsequent breach.
- (2) The following department actions do not waive the department's rights or power under the contract:
 1. Payment for or acceptance of all or portions of the work.
 2. Extension of contract time.
 3. Possession of the work.
- (3) Assume liability for latent defects, fraud, gross mistakes as may amount to fraud, or as regards to the department's rights under a warranty or guaranty without prejudice to the terms of the contract.

107.17 Railroad-Highway Grade Separations and Approaches, New Railroad Crossings, and Operations on Railroad Right-of-Way

107.17.1 General

- (1) The railroad's chief engineering officer may inspect the work and contractor operations on grade separations and their approaches, grade crossings, or on railroad right-of-way. Perform the work in a manner satisfactory to the railroad's chief engineering officer.
- (2) Perform all work within the railroad's right-of-way in a manner that does not interfere with the safe and uninterrupted operation of railroad traffic. Maintain clearances during construction as follows:
 1. Do not operate equipment closer than 25 feet (7.6 m) horizontally from a track centerline or 22 feet (6.7 m) vertically above the top of a rail, except under the protection of railroad flaggers.
 2. Do not store materials or equipment closer than 25 feet (7.6 m) horizontally from a track centerline.
 3. Provide an obstruction-free work zone adjacent to a track extending 12 feet (3.6 m) or more horizontally on both sides of the track centerline. Keep this work zone free of construction debris.
 4. Unless the railroad's chief engineering officer approves otherwise in writing, maintain minimum clearances from falsework, forms, shoring, and other temporary fixed objects as follows:
 - 4.1 Provide 12 feet (3.6 m), plus 1.5 inches (38 mm) per degree of track curvature, measured horizontally from the track centerline.
 - 4.2 Provide 21 feet (6.4 m), plus compensation for super-elevated track, measured vertically above the top of the highest rail.
- (3) Comply with the railroad's rules and regulations regarding operations on railroad right-of-way. If the railroad's chief engineering officer requires, arrange with the railroad to obtain the services of qualified railroad employees to protect railroad traffic through the work. Bear the cost of these services and make payment directly to the railroad. Notify the railroad's chief engineering officer in writing at least 3 business days before starting work near a track. Provide the specific time planned to start the operations.
- (4) Do not blast on the railroad's right-of-way without the written permission of the railroad's chief engineering officer. At least 3 business days before blasting, inform the responsible railroad official if explosives will be detonated within 100 yards (91 m) of a track. Provide specific dates, times, and locations for all blasting.
- (5) Develop shop drawings, with detailed plans and computations, for the following temporary construction:
 1. Falsework and forms of highway structures spanning a track.
 2. Forms for piers and abutments adjacent to a track.
 3. Shoring, if the contract requires shoring of an excavation near a track.

- (6) Have a registered professional engineer sign and seal the shop drawings. At least 30 calendar days before starting falsework, form, or shoring construction; submit 3 sets of shop drawings to the railroad's chief engineering officer and one set to the engineer. The engineer and the railroad may review the shop drawings. If the engineer or the railroad finds the shop drawings unsatisfactory, the contractor shall make the required changes. A satisfactory shop drawing review does not relieve the contractor of responsibility and liability for the structural integrity and proper functioning of the falsework, forms, or shoring.
- (7) Make all necessary arrangements for crossing a railroad's track at a location other than an existing public crossing. Bear all costs incident to that crossing, including flagging costs.

107.17.2 Work by Railroad

- (1) The railroad company may undertake certain work or operations incident to the project that are the subject of an agreement between the department and the railroad company. Do not alter this work without the consent of the railroad company. Should the railroad company elect to have contractor-requested alterations made with railroad company forces, the contractor shall bear the cost of the alterations and make payment directly to the railroad company.
- (2) Bear the cost of the movement or adjustment of telegraph, telephone, or signal facilities owned, operated, or maintained by the railroad company and not otherwise provided for in the contract or in agreements between the department and the railroad company.

107.17.3 Railroad Insurance Requirements

- (1) If required by the special provisions, provide or arrange for a subcontractor to provide railroad protective liability insurance in addition to the types and limits of insurance required in [107.26](#). Keep railroad protective liability insurance coverage in force until completing all work, under or incidental to the contract, on the railroad right-of-way or premises of the railroad and until the department has accepted the work as specified in [105.11.2.4](#).
- (2) Provide railroad protective liability insurance coverage written as specified in 23 CFR part 646 subpart A. Provide a separate policy for each railroad owning tracks on the project. Ensure that the railroad protective liability insurance policies provide the following minimum limits of coverage:
 - 1. Coverage A, bodily injury liability and property damage liability; \$2 million per occurrence.
 - 2. Coverage B, physical damage to property liability; \$2 million per occurrence.
 - 3. An annual aggregate amount of \$6 million that shall apply separately to each policy renewal or extension.
- (3) Submit the following to each railroad owning tracks on the project as evidence of that railroad's respective coverage:
 - 1. A certificate of insurance for the types and limits of insurance specified in [107.26](#).
 - 2. The railroad protective liability insurance policy or other acceptable documentation to the railroad company.
- (4) Submit the following to the department as evidence of the required coverage:
 - 1. A copy of the letter to the railroad company transmitting the submittal documents specified in 107.17.3(3).
 - 2. A certificate of insurance for the required railroad protective liability coverages.
- (5) The contractor shall not begin work on the right-of-way or premises of the railroad company until the department receives the submittals specified in 107.17.3(4) and notification from the railroad company that the contractor has provided sufficient insurance information to begin work.
- (6) Notify the department at least 60 calendar days before a cancellation or material change in coverage. Only obtain coverage from insurance companies licensed to do business in Wisconsin that have an A.M. Best rating of A- or better. The cost of providing the required insurance coverage and limits is incidental to the contract. The department will make no additional or special payment for providing insurance.

107.18 Environmental Protection

- (1) Comply with all applicable federal, state, and local laws and regulations that control the prevention of pollution of the environment.
- (2) Comply with the pertinent requirements of laws relating to solid waste disposition and air pollution. Control and minimize the dispersion of dust and particulate matter and other pollutants into the atmosphere.

- (3) Take all necessary precautions to prevent pollution of streams, lakes, wetlands, and reservoirs with fuels, oils, bitumens, calcium chloride, magnesium chloride, paint, or other harmful materials. Conduct and schedule work operations to avoid or minimize siltation of streams, lakes, and reservoirs. Protect drainage ways, culverts, and drainage structures from debris caused by a contractor operation.
- (4) Do not ford live streams unless a plan for the fording operation meets the engineer's approval and results in minimum siltation to the streams. Do not operate machinery on the bed of live streams.
- (5) Remove existing structures over live streams in large pieces, minimizing the number of smaller pieces that may drop into the water or wetlands. Remove from the water or wetlands all steel and all concrete pieces or other debris larger than 5 inches (127 mm) in any dimension.
- (6) If work areas or pits are located in or adjacent to live streams, lakes, or wetlands, separate the work areas or pits from the stream, lake, or wetland by a dike, silt fence, or other barrier to keep sediment from entering these locations. Take care during the construction and removal of these barriers to minimize the siltation or filling of the stream, lake, or wetland.
- (7) Treat water from aggregate washing or other sediment producing operations by filtration, a settling basin, or other means sufficient to reduce the sediment content to not more than that of the stream or lake into which the water is discharged.

107.19 Construction Over or Adjacent to Navigable Waters

- (1) Within 107.19, the term "governmental authority" means the U.S. Army Corps of Engineers, the U.S. Coast Guard, the WDNR, or other agency having jurisdiction over the navigable waters within the project limits and empowered to take the actions specified in 107.19.
- (2) Conduct all work over, on, or adjacent to navigable waters so that free navigation of the waterways is not impeded and existing navigable depths are not impaired except as allowed by permit issued by the governmental authority. Obtain all permits before beginning construction.
- (3) Procure all permits required by [107.3](#). Submit applications for U.S. Coast Guard and WDNR permits to the boating law administrator of the WDNR bureau of law enforcement. Provide one copy of each permit to the project engineer for posting in the field office before construction activities affecting navigation begin.
- (4) The governmental authority may supervise all construction and related operations as is customary for operations in navigable waters. Conform to special requirements or directions from the governmental authority.
- (5) Ascertain from the governmental authority the minimum horizontal and vertical clearance requirements for navigation during construction, and maintain those clearances during the period of construction.
- (6) If the governmental authority during progress of the work issues directions or orders affecting the contractor's operations or order of procedure, the contractor shall promptly file with the engineer a written copy of the directions or orders.
- (7) Should the contractor during the progress of the work lose, dump, throw overboard, sink, or misplace material or equipment, which in the opinion of the governmental authority may interfere with or obstruct navigation, the contractor shall promptly recover or remove the same. Give immediate notice with descriptions and locations of possible obstructions to the governmental authority. If the governmental authority requires, mark or buoy the obstructions until their removal. Should the contractor refuse, neglect, or delay compliance with the above requirements, the governmental authority may remove the obstructions. The department may deduct the cost of this removal from payments due to the contractor, or may recover the cost under the bond deposited by the contractor.
- (8) During construction, provide temporary lights, waterway markers, other devices, or combination thereof as the governmental authority specifies and requires.
- (9) All expenses the contractor incurs to maintain navigation are incidental to the contract cost. The department will allow no additional payment for this work.

107.20 Erosion Control

- (1) Perform the temporary and permanent erosion control measures and the storm water management measures required by Trans 401 of the Wisconsin administrative code, the contract, and as the engineer directs.

- (2) Coordinate temporary erosion control measures with the permanent erosion control measures to ensure economical, effective, and continuous erosion control.
- (3) Prepare and submit an ECIP for the project, including borrow sites and material disposal sites, according to Trans 401 of the Wisconsin administrative code. Perform the work according to the ECIP.
- (4) The engineer may limit the area of erosive land that the contractor may expose to the elements by grubbing, excavation, borrow, or fill operations at any one time. Provide the shortest duration that is practical for this exposure before final trimming, finishing, and seeding, or application of temporary erosion control measures.
- (5) Perform construction in and adjacent to rivers, streams, lakes, or other waterways in a manner to avoid washing, sloughing, or deposition of materials into the waterways that would obstruct or impair the flow of the waterways and thus endanger the roadway or stream banks, or that would result in undue or avoidable contamination, pollution, or siltation of these waterways.
- (6) The engineer has full authority to suspend or limit grading and other operations pending adequate performance of permanent erosion control measures, such as finish grading, topsoiling, mulching, matting, and seeding, and all temporary erosion control measures that the engineer orders.
- (7) Perform grubbing and grading operations in sequence with other work to minimize erosion. Construct intercepting ditches or dikes as soon as it is practical after completing clearing and grubbing operations and before or during the operations of excavating the cuts. Where erosion is likely to be a problem, provide the permanent erosion control measures immediately after performing grading operations, unless the engineer authorizes temporary erosion control measures.
- (8) Except as limited by [628.4.12](#) and [628.5.12](#) for borrow sites and material disposal sites, the engineer will measure, and the department will pay for, temporary and permanent erosion control as provided for by the various contract bid items or as extra work, if this work is not specified in the contract. However, the department will not pay for this work if the engineer requires temporary erosion control because of the contractor's negligence, carelessness, or failure to install permanent controls.

107.21 Use of Fire Hydrants

- (1) If the contractor desires to use water from public hydrants, the contractor shall make application to the proper authorities and shall conform to their ordinances, rules, and regulations concerning fire hydrant use.
- (2) Ensure that fire hydrants are accessible at all times to the fire department. Do not place material or other obstructions closer to a fire hydrant than allowed by ordinances, rules, or regulations, or within 5 feet (1.5 m) of a fire hydrant in the absence of specific ordinances, rules, or regulations.

107.22 Contractor's Responsibility for Utility Facilities, Property, and Services

- (1) The department expressly reserves for the proper authorities of the municipality in which the work is done the right to construct utility services in the highway or street, or to grant permits for the same, at any time. Coordinate and cooperate with utilities in the removal and rearrangement of existing facilities to minimize their service interruption and duplication of work by the utilities. At least 3 business days before breaking ground, the contractor shall notify the proper utility authorities that the contractor's operations may affect their facilities including: streets, gas and water pipes, electric and other conduits, railroads, poles, manholes, catch basins, sewers, and other property. Never hinder or interfere with utility representatives in the protection or operation of their facilities. Obtain all necessary information regarding existing facilities. Protect existing facilities from damage and unnecessary exposure.
- (2) Obtain all necessary information regarding the planned installation of new facilities identified in the contract. Make proper provision and give proper notification so the utilities can install new facilities at the proper time without delay or unnecessary inconvenience. Do not pave over the location of a new underground facility, planned for installation concurrently with this contract, before installing the facility.
- (3) If the contractor damages or interrupts service, the contractor shall notify the utility promptly. Coordinate and cooperate with the utility in the repair of the facility. The department will determine who is responsible for repair costs as specified in Wisconsin statutes 66.0831 and 182.0175(2).
- (4) If the contractor finds facilities not identified in the contract, the engineer will determine whether adjustment or relocation of the facility is necessary to accommodate contract work. The engineer will arrange with the utility or the contractor to adjust or relocate the facility. If deemed necessary, the engineer will revise the contract as specified in [104.2](#).

- (5) If specified in the contract, the contractor and the department will comply with administrative rule, Trans 220 of the Wisconsin administrative code.

107.23 Antitrust Assignment Clause

- (1) The contractor hereby assigns to the department all claims for overcharges resulting from antitrust violations as to goods and materials purchased in connection with this contract, except as to overcharges that result from antitrust violations commencing after the price is established under this contract and any change order. In addition, the contractor warrants and represents that each of the contractor's first tier suppliers and subcontractors shall assign all antitrust violation claims to the state subject to the aforementioned exception.

107.24 Hazardous Substances

- (1) Whenever the construction operations encounter or expose an abnormal condition that may indicate the presence of a hazardous substance, immediately discontinue construction operations near the abnormal condition and notify the engineer. Treat all abnormal conditions with extreme caution. Abnormal conditions include, but are not limited to, the following:
1. The presence of a tank or barrel.
 2. An obnoxious odor.
 3. Excessively hot earth.
 4. Smoke.
 5. Visible fumes.
 6. Discolored earth or sheen on groundwater.
- (2) Do not resume construction operations in this area until the engineer so directs. The contractor may continue work in other areas of the project unless the engineer otherwise directs.
- (3) Take actions to prevent the hazardous substance from spreading into an uncontaminated area.
- (4) Dispose of hazardous substances conforming to the requirements and regulations of the responsible state or federal agencies. If the engineer requires the contractor to dispose of the hazardous substance and the contract does not provide for this work, the work is extra work as specified in [104.2](#). If the responsible state or federal agency requires special procedures for the disposal, the department will arrange with qualified persons to dispose of the substance.

107.25 Archeological and Historical Findings

- (1) For construction operations on the project, if encountering human remains or if encountering artifacts of potential archeological or historical significance, immediately cease operations at the encounter site and notify the engineer. Cooperate, as necessary, by moving construction operations from the encounter site and complying with the engineer's directions. The contractor may continue work elsewhere on the project unless the engineer directs otherwise. Do not resume operations at the encounter site without the engineer's permission.
- (2) For construction operations on private property, if encountering human remains or if encountering artifacts of potential archeological or historical significance, immediately cease operations at the encounter site and notify the engineer and the responsible state agencies. Cooperate, as necessary, by moving construction operations from the encounter site and complying with the responsible state agencies' directions. Do not resume operations at the encounter site without the responsible state agencies' permission.

107.26 Standard Insurance Requirements

- (1) Maintain the following types and limits of commercial insurance in force until completing and obtaining the department's acceptance of all work as specified in [105.11.2.4](#).

TYPE OF INSURANCE	MINIMUM LIMITS REQUIRED ^[1]
1. Commercial general liability insurance; shall be endorsed to include blanket contractual liability coverage.	\$2 Million Combined single limits per occurrence; may be subject to an annual aggregate limit of not less than \$4 Million.
2. Workers' compensation and employers' liability insurance.	Workers' compensation limits: statutory limits Employers' liability limits: Bodily injury by accident: \$100,000 each accident Bodily injury by disease: \$500,000 each accident \$100,000 each employee
3. Commercial automobile liability insurance; shall cover all contractor-owned, non-owned, and hired vehicles used in carrying out the contract.	\$1 million-combined single limits per occurrence.

^[1] The contractor may satisfy these requirements through primary insurance coverage or through excess/umbrella policies.

- (2) Each bidder shall provide the department with certificates of insurance as evidence that required coverages for insurance types 1, 2, and 3 are in force. The bidder shall provide certificates of insurance in their prequalification statement as specified in [102.1](#).
- (3) Notify the department at least 60 calendar days before a cancellation or material change in coverage. Only obtain coverage from insurance companies licensed to do business in the state that have an A.M. Best rating of A- or better. The cost of providing the required insurance coverage and limits is incidental to the contract. The department will make no additional or special payment for providing insurance.
- (4) The above insurance requirements shall apply with equal force whether the contractor or a subcontractor, or anyone directly or indirectly employed by either, performs the work under the project.

SECTION 108 PROSECUTION AND PROGRESS

108.1 Subletting the Contract

- (1) Do not sublet, sell, transfer, assign, or otherwise dispose of the contract, a portion of the contract, or a right, title, or interest in the contract without the engineer's written consent. If the engineer consents to the contractor subletting a portion of the contract, the contractor is relieved of no responsibility for the fulfillment of the contract or of no liability under the contract and bond. Do not allow a subcontractor to proceed with work without the engineer's written consent.
- (2) Request permission in writing to sublet a portion of the contract. If the engineer requires, submit evidence that the proposed subcontractor is experienced and equipped for the work. The engineer may also require submission of a copy of the proposed subcontract. Submit all subsequent changes in the terms of a subcontract for the engineer's consent.
- (3) The contractor shall perform at least 30 percent of the original contract amount with the contractor's own organization. Submit documentation tabulating the bid amount for each bid item and indicating whether the contractor or a subcontractor is performing that work. For this computation, do not distribute work within a single bid item between the contractor and subcontractors. Include a detailed computation showing the contractor's share of the work as follows:

$$\text{Contractor's share} = P / (C - S)$$

Where:

P = Prime contractor performed bid items. Do not include materials the prime purchases for subcontractor installation, or equipment and associated operators the prime leases to a subcontractor.

C = Total contract amount.

S = Subcontractor performed specialty work bid items. Specialty work includes work performed under any bid item in the designated sections or under special provision bid items for similar work as follows:

- Contractor staking work under section 650.
- Electrical work under sections 651 - 678.
- Landscaping and erosion control work under sections 626 - 632.
- Traffic control work under section 643.
- Signing work under sections 633 - 638 and section 641.
- Pavement marking work under sections 646 - 649.
- Fencing work under section 616.

- (4) If proposing to have a party other than a subcontractor perform work, inform the engineer and submit details of this arrangement in writing. The engineer will determine if that arrangement constitutes subcontracting. The engineer may also require the contractor to file, with the engineer, copies of all other agreements between any parties regarding the performance of work under the contract.

108.2 Start of the Work

- (1) For the purpose of determining contract time, the contract starting date is defined as follows:

If the contract provides for starting work not later than 10 calendar days after the date of written notification from the engineer, the contract starting date will be the date construction operations are started or the tenth calendar day following the date of that notification, whichever is earlier.

108.3 Prosecution of the Work

- (1) The department will issue a written notification to begin or resume work for all working day, calendar day, and completion date contracts. Do not begin or resume work before receiving the engineer's written notification. Notify the engineer at least 3 business days before starting or resuming work. Notify the engineer at least one business day before changing the schedule of work, such as working on Saturdays, Sundays, and department-specified holidays.
- (2) Give the work the constant attention necessary to promote the progress of the work. Promptly supply the materials, tools, equipment, and incidental items required to perform the work. Employ an ample force of workers and provide a construction plant properly adapted to the work and of sufficient capacity and efficiency to accomplish the work in a safe and skillful manner as provided in the contractor's progress schedule. Maintain all plants in good working order and make provisions for immediate emergency repairs.

- (3) Take precautions necessary to protect the work as specified in [107.14](#). Include in the contract price the cost for taking precautions and protecting the work. The cost of taking precautions and protecting the work is incidental to the work as specified in [109.2](#) and [109.6.1](#).

108.4 Progress Schedules

108.4.1 General

- (1) Submit a bar chart progress schedule as specified in 108.4.2. The contractor may alternatively submit one of the following:
1. A linear schedule conveying all the information specified in 108.4.2 for a bar chart.
 2. A relationship bar chart (RBC) schedule as specified in [108.4.3](#).
 3. A critical path method (CPM) schedule as specified in [108.4.4](#).
- (2) If special provisions require, submit an RBC schedule as specified in [108.4.3](#) or a CPM schedule as specified in [108.4.4](#), and do not submit a bar chart schedule.
- (3) Plan and execute the work to meet the contract-required interim completion dates and the specified contract time or completion date. The engineer will use the schedule to monitor the progress of the work. The schedule is not part of the contract.

108.4.2 Bar Chart Progress Schedule

108.4.2.1 Initial Bar Chart Progress Schedule

- (1) At least 14 calendar days before the preconstruction meeting, submit to the engineer for review an initial bar chart progress schedule conforming to the following minimum requirements:
1. Include activities that describe essential features of the work and activities that might potentially delay contract completion. Identify activities that are controlling items of work.
 2. Identify the contemplated start and completion dates for each activity. Provide a duration, ranging from one to 15 working days, for each activity. Break longer activities into 2 or more activities distinguished by the addition of a location or some other description. Specify the sequencing of all activities.
 3. Provide the quantity and the estimated daily production rate for controlling items of work.
 4. Include a narrative that lists the work days per week, department-specified holidays, number of shifts per day, and number of hours per shift. For calendar day and completion date contracts, provide the estimated number of adverse weather days for each month consistent with the monthly-anticipated adverse weather days shown in [108.10.2.2](#).
 5. Show completing the work within interim completion dates and the specified contract time or completion date.
- (2) In addition to the required activities, the contractor is encouraged to include other activities such as:
1. The procurement of materials, equipment, articles of special manufacture, etc.
 2. The furnishing of drawings, plans, and other data required in the contract for the engineer's review.
 3. The department's inspections of structural steel fabrication, etc.
 4. Third party activities related to the contract.
- (3) Hand drawn schedules are acceptable. If the contractor develops the initial schedule with scheduling software, the contractor is encouraged to provide the engineer a diskette of the schedule and the name of the scheduling software used.
- (4) The engineer and contractor will review the initial schedule at the preconstruction meeting. Within 5 business days after the preconstruction meeting, the engineer will accept the contractor's initial schedule or request additional information. Make the appropriate adjustments and resubmit the revised initial schedule within 5 business days after the engineer's request. If the engineer requests justification for an activity duration, provide information that may include estimated labor, equipment, unit quantities, and production rates used to determine the activity duration.
- (5) The department will only make progress payments for the value of materials, as specified in [109.6.3.2](#), until the engineer accepts the initial schedule. The engineer accepts the contractor's initial schedule based solely on whether that schedule is complete as specified in 108.4.2.1(1). The engineer's acceptance of the schedule does not modify the contract or validate the schedule.

108.4.2.2 Monthly Progress Meetings and Bar Chart Progress Schedule Updates

- (1) The contractor and the engineer will meet monthly to assess progress and jointly add update information to the initial schedule. At a minimum, updates will include the actual start and finish of each activity, percentage complete, and remaining durations of activities started but not yet completed.

108.4.2.3 Engineer's Right to Request Bar Chart Progress Schedule Revisions

- (1) The engineer will monitor the progress of the work and may request that the contractor revise the schedule if project completion or interim completion targets are delayed 14 calendar days or more for calendar day or completion date contracts, or 10 working days or more for working day contracts. Submit the revised schedule within 5 business days after the engineer's request.

108.4.2.4 Bar Chart Progress Schedule Documentation for Time Extensions

- (1) Furnish documentation including schedule updates to support requests to extend interim completion dates, the specified contract time, or the completion date.
- (2) If the contractor does not furnish documentation to support the additional time needed to complete work on increased quantities for an excusable delay that affects a controlling item of work, the engineer may extend contract time, rounded to the nearest 1/2 day, as follows:

$$TE = OT \times (ATC - OC)/OC$$

Where:

TE = Time extension

OT = Original time (original contract time)

OC = Original cost (total bid amount)

ATC = Adjusted total cost (actual cost of all work minus the cost of change order work where contract time was determined)

108.4.2.5 Bar Chart Progress Schedule Measurement and Payment

- (1) Include the cost for the schedule in the total bid. The schedule is incidental to the contract.

108.4.3 Relationship Bar Chart Progress Schedule

108.4.3.1 General

- (1) If special provisions require, submit a RBC Progress Schedule.

108.4.3.2 Initial RBC Progress Schedule

- (1) At least 14 calendar days before the preconstruction meeting, submit to the engineer for review an initial RBC schedule that meets the following minimum requirements:
 1. Include activities that describe essential features of the work and activities that might potentially delay contract completion. Identify activities that are controlling items of work.
 2. Identify the contemplated start and completion dates for each activity. Provide a duration, ranging from one to 15 working days, for each activity. Break longer activities into 2 or more activities distinguished by the addition of a location or some other description.
 3. Provide a logic diagram that shows the sequence of activities and the scheduling interrelationships among activities. Alternatively, the contractor may identify the activity interrelationships in a tabular listing. Ensure all activity interrelationships are finish to start relationships with no leads or lags. Use only contractual constraints in the schedule logic. The engineer may accept requested exceptions.
 4. Provide the quantity and the estimated daily production rate for controlling items of work.
 5. Include a narrative that lists the work days per week, department-specified holidays, number of shifts per day, and number of hours per shift. For calendar day and completion date contracts, provide the estimated number of adverse weather days for each month consistent with the monthly-anticipated adverse weather days shown in [108.10.2.2](#).
 6. Show completing the work within interim completion dates and the specified contract time or completion date.
 7. Develop the RBC schedule using computerized scheduling software. Provide the engineer with a paper copy of the information required in items 3 and 5 of 108.4.3.2(1). Submit a diskette of the schedule and identify the software used to prepare that schedule.

- (2) In addition to the required activities, the contractor is encouraged to include other activities such as:
 1. The procurement of materials, equipment, articles of special manufacture, etc.
 2. The furnishing of drawings, plans, and other data required in the contract for the engineer's review.
 3. The department's inspections of structural steel fabrication, etc.
 4. Third party activities related to the contract.
- (3) The contractor may augment the initial submittal of the RBC schedule by submitting a linear schedule. The linear schedule must be generated from the RBC schedule.
- (4) The engineer and the contractor will review the initial schedule at the preconstruction meeting. Within 5 business days after the preconstruction meeting, the engineer will accept the contractor's initial schedule or request additional information. Make the appropriate adjustments and resubmit the revised initial schedule within 5 business days after the engineer's request. If the engineer requests justification for an activity duration, provide information that may include estimated labor, equipment, unit quantities, and production rates used to determine the activity duration.
- (5) The department will only make progress payments for the value of materials, as specified in [109.6.3.2](#), until the engineer accepts the initial schedule. The engineer accepts the contractor's initial schedule based solely on whether that schedule is complete as specified in 108.4.3.2(1). The engineer's acceptance of the schedule does not modify the contract or validate the schedule.

108.4.3.3 Monthly RBC Progress Schedule Updates and Progress Meetings

- (1) Update the schedule monthly to show current progress. At a minimum, ensure that the update includes:
 1. The actual start and finish of each activity, percentage complete, and remaining durations of activities started but not yet completed.
 2. A narrative report that includes a listing of monthly progress, changes to the controlling items of work from the previous update, sources of delay, potential problems, work planned for the next 30 calendar days, and changes to the RBC schedule. Changes include, but are not limited to, changes in the method and manner of performing the work, changes in the contract, extra work, changes in an activity duration, and changes to relationships between activities.
- (2) For each schedule update, submit a diskette and an updated paper copy meeting the requirements in [108.4.3.2\(1\)](#).
- (3) Within 5 business days after submitting the monthly update, hold a job-site meeting with the engineer to review the progress of the schedule. At that meeting, the department will confirm the actual start and actual finish dates of completed activities, remaining durations of uncompleted activities, and changes to the controlling items of work.

108.4.3.4 Engineer's Right to Request RBC Progress Schedule Revisions

- (1) Between monthly updates, the engineer will monitor the progress of the work and may request that the contractor revise the schedule for one or more of the following reasons:
 1. The project completion or interim completion targets are delayed 14 calendar days or more for calendar day or completion date contracts, or 10 working days or more for working day contracts.
 2. The engineer determines that the progress of the work differs significantly from the current schedule.
 3. A contract change order requires the addition, deletion, or revision of activities that causes a change in the contractor's work sequence or the method and manner of performing the work.
- (2) Submit the revised schedule within 5 business days after the engineer's request.
- (3) Within 5 business days after submitting the revised schedule, hold a job-site meeting to review the schedule revisions. At the meeting, the engineer will accept the contractor's schedule or request additional information. Make the appropriate adjustments and resubmit the newly revised schedule.

108.4.3.5 RBC Progress Schedule Documentation for Time Extensions

- (1) Furnish documentation, including schedule updates, to support requests to extend interim completion dates, the specified contract time, or completion date.

108.4.3.6 RBC Progress Schedule Measurement

- (1) If special provisions require an RBC schedule, the department will measure one RBC Progress Schedule for each contract acceptably completed.

108.4.3.7 RBC Progress Schedule Payment

- (1) The department will pay for the measured quantity at the contract unit price under the following bid item:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
108.4300	RBC Progress Schedule	EACH

- (2) Payment is full compensation for all work required under this bid item. The department will pay the contract amount in 3 payments as follows:

1. The department will make the first payment, equal to 50% of the amount bid for this bid item, after the department accepts the initial schedule.
2. The department will make the second payment, equal to 25% of the amount bid for this bid item, when the contractor completes work representing 40% of the total contract price, excluding the price for this bid item.
3. The department will make the third payment, equal to 25% of the amount bid for this bid item, when the contractor completes work representing 80% of the total contract price, excluding the price for this bid item.

108.4.4 Critical Path Method Progress Schedule

108.4.4.1 General

- (1) If special provisions require, submit a CPM Progress Schedule.

108.4.4.2 Initial Work Plan

- (1) At least 14 calendar days before the preconstruction meeting, submit an initial work plan conforming to, as a minimum, the following requirements:
1. Include a detailed bar chart schedule, meeting the requirements of [108.4.2.1\(1\)](#), for the first 60 calendar days of work. Ensure that all activities have durations of one to 15 working days, unless the engineer accepts requested exceptions. Show additional activities that require department review or approval.
 2. Include a summary bar chart schedule for the balance of the project. Summary activities may be greater than 15 working days.
 3. Ensure the bar chart schedules show completing the work within the interim completion dates and specified contract time or completion date.
- (2) The engineer and the contractor will review the initial work plan at the preconstruction meeting. Within 5 business days after the preconstruction meeting, the engineer will accept the contractor's initial work plan or request additional information. The engineer will use the detailed bar chart schedule to monitor the progress of the work until accepting the initial CPM schedule.
- (3) Maintain and submit on a bi-weekly basis an updated version of the detailed bar chart schedule until the department accepts the initial CPM schedule. Ensure that each schedule update includes the actual start and finish of each activity, percentage complete, and the remaining durations of activities started but not yet completed.

108.4.4.3 Initial CPM Progress Schedule

- (1) Within 30 calendar days after the notice to proceed, submit to the engineer for review an initial CPM schedule, beginning at the start of work date and conforming to the following minimum requirements:
1. Include activities that describe essential features of the work and activities that might potentially delay contract completion. Identify activities that are controlling items of work.
 2. Identify the contemplated start and completion dates for each activity. Provide a duration, ranging from one to 15 working days, for each activity. Break longer activities into 2 or more activities distinguished by the addition of a location or some other description.
 3. Provide a logic diagram having a maximum of 50 activities for each 11 in. by 17 in. sheet. Ensure that each sheet includes title, match data for diagram correlation, and a key to identify all components used in the diagram. Show the sequence of activities and the scheduling interrelationships among activities. Ensure all activity interrelationships are finish to start relationships with no leads or lags. Use only contractual constraints in the schedule logic. The engineer may accept requested exceptions.
 4. Provide the quantity and the estimated daily production rate for controlling items of work.
 5. Include a narrative that lists the work days per week, department-specified holidays, number of shifts per day, and number of hours per shift. For calendar day and completion date contracts, provide the estimated number of adverse weather days for each month consistent with the monthly-anticipated adverse weather days shown in [108.10.2.2](#).

6. Provide tabular sorts by:
 - Activity Identification/Early Start.
 - Total Float.
 - Predecessor/Successor.
 - Responsibility/Early Start.
 - Area/Early Start.
 7. Provide 60-day look-ahead bar charts by early start.
 8. Show completing the work within interim completion dates and the specified contract time or completion date.
 9. Develop the CPM schedule using computerized scheduling software. Provide the engineer with a paper copy of the information required in items 3, 5, 6, and 7 of [108.4.4.3\(1\)](#). Submit a diskette of the schedule and identify the software used to prepare that schedule.
- (2) In addition to the required activities, the contractor is encouraged to include other activities such as:
1. The procurement of materials, equipment, articles of special manufacture, etc.
 2. The furnishing of drawings, plans, and other data required in the contract for the engineer's review.
 3. The department's inspections of structural steel fabrication, etc.
 4. Third party activities related to the contract.
- (3) Float is defined as the amount of time between the date when an activity can start, the early start, and the date when an activity must start, the late start. The department and the contractor agree that float is a shared commodity, and is not for the exclusive use or financial benefit of either party. Either party has the full use of the float until it is depleted.
- (4) The contractor may augment the initial submittal of the CPM schedule by submitting a linear schedule. The linear schedule must be generated from the CPM schedule.
- (5) Attend a meeting to review the schedule. The engineer will schedule the meeting within 10 business days after receiving the contractor's initial CPM schedule submittal. Within 5 business days after the meeting, the engineer will accept the contractor's initial CPM schedule or request additional information. Make the appropriate adjustments and resubmit the revised initial CPM schedule within 10 business days after the engineer's request. If the engineer requests justification for an activity duration, provide information that may include estimated labor, equipment, unit quantities, and production rates used to determine the activity duration.
- (6) The department will only make progress payments for the value of materials, as specified in [109.6.3.2](#), until the contractor has submitted the initial CPM schedule. The department will retain 10 percent of each estimate until the department accepts the initial CPM schedule.
- (7) The engineer accepts the contractor's initial CPM schedule based solely on whether that schedule is complete as specified in [108.4.4.3\(1\)](#). The engineer's acceptance of the schedule does not modify the contract or validate the schedule.

108.4.4.4 Monthly CPM Progress Schedule Updates and Progress Meetings

- (1) Update the schedule monthly to show current progress. At a minimum, ensure that the update includes:
1. The actual start and finish of each activity, percentage complete, and remaining durations of activities started but not yet completed.
 2. A narrative report that includes a listing of monthly progress, changes to the controlling items of work from the previous update, sources of delay, potential problems, work planned for the next 30 calendar days, and changes to the CPM schedule. Changes include, but are not limited to, changes in the method and manner of performing the work, changes in the contract, extra work, changes in an activity duration, and changes to relationships between activities.
- (2) For each schedule update, submit a diskette and an updated paper copy of the following:
1. Tabular sorts by:
 - Activity Identification/Early Start.
 - Total Float.
 2. If applicable, an updated logic diagram as the engineer requires.
 3. If augmenting the CPM schedule with a linear schedule, provide an update of the linear schedule.

- (3) Within 5 business days after submitting the monthly update, hold a job-site meeting with the engineer to review the progress of the schedule. At that meeting, the department will confirm the actual start and actual finish dates of completed activities, remaining durations of uncompleted activities, changes to the controlling items of work, and the logic changes.

108.4.4.5 Engineer's Right to Request CPM Progress Schedule Revisions

- (1) Between monthly updates, the engineer will monitor the progress of the work and may request that the contractor revise the schedule for one or more of the following reasons:
 1. The project completion or interim completion targets are delayed 14 calendar days or more for calendar day or completion date contracts, or 10 working days or more for working day contracts.
 2. The engineer determines that the progress of the work differs significantly from the current schedule.
 3. A contract change order requires the addition, deletion, or revision of activities that causes a change in the contractor's work sequence or the method and manner of performing the work.
- (2) Submit the revised schedule within 10 business days after the engineer's request.
- (3) Within 5 business days after submitting the revised schedule, hold a job-site meeting to review the schedule revisions. At the meeting, the engineer will accept the contractor's schedule or request additional information. Make the appropriate adjustments and resubmit the newly revised schedule.

108.4.4.6 CPM Progress Schedule Documentation for Time Extensions

- (1) Furnish documentation, including schedule updates, to support requests to extend interim completion dates, the specified contract time, or completion date.

108.4.4.7 CPM Progress Schedule Measurement

- (1) If special provisions require a CPM schedule, the department will measure one CPM Progress Schedule for each contract acceptably completed.

108.4.4.8 CPM Progress Schedule Payment

- (1) The department will pay for the measured quantity at the contract unit price under the following bid item:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
108.4400	CPM Progress Schedule	EACH

- (2) Payment is full compensation for all work required under this bid item. The department will pay the contract amount in 3 payments as follows:
 1. The department will make the first payment, equal to 50% of the amount bid for this bid item, after the department accepts the initial schedule.
 2. The department will make the second payment, equal to 25% of the amount bid for this bid item, when the contractor completes work representing 40% of the total contract price, excluding the price for this bid item.
 3. The department will make the third payment, equal to 25% of the amount bid for this bid item, when the contractor completes work representing 80% of the total contract price, excluding the price for this bid item.

108.5 Limiting Operations

- (1) Limit operations to prevent undue inconvenience to the traveling public. If the engineer concludes that the extent of the contractor's work zone unnecessarily inconveniences the public, the engineer will require the contractor to finish sections in progress before allowing the contractor to start work on additional sections.

108.6 Character of Workers

- (1) Provide personnel necessary to supervise and complete all contract work as specified. Ensure workers have the experience and skills necessary to perform assigned work.
- (2) Remove from the project all personnel performing in an unskilled manner or who are intemperate or disorderly. If the engineer concludes that personnel are performing in an unskilled manner or are intemperate or disorderly, the engineer may direct the contractor, in writing, to remove them from the project. Do not allow removed personnel to return to the project without the engineer's written consent.
- (3) The engineer may suspend the work in writing, withhold progress payments due the contractor, or both for the following reasons:
 1. The contractor does not furnish suitable and sufficient personnel to perform the work.
 2. The contractor does not remove personnel from the project as specified in 108.6(2).

108.7 Methods and Equipment

108.7.1. General

- (1) Use equipment of the capacity and mechanical condition necessary to perform work conforming to the contract. Ensure that the equipment does not harm the roadway, pavement, structures, adjacent property, other highways, workers, or the public. Use equipment conforming to the specific contract requirements for individual bid items or classes of work.
- (2) If the contractor does not provide adequate equipment, properly maintained, the engineer may:
 1. Order the contractor to remove the equipment.
 2. Suspend specific operations until the contractor provides adequate equipment.
 3. Determine that the contractor is in default of the contract.
- (3) Equip each unit of motorized construction equipment with a muffler constructed to the equipment manufacturer's specifications. The contractor may substitute other mufflers producing equivalent results. Maintain mufflers and exhaust systems in good operating condition, free from leaks and holes.

108.7.2 Moving Heavy Loads

- (1) For all vehicles operated on completed subgrade, base, pavement, or structures that will remain a permanent part of the project, do not exceed the legal loading defined in Wisconsin statutes for Class A highways without the engineer's written permission. Adhering to these requirements, or allowed variations, does not relieve the contractor of liability for damage caused by those operations.

108.8 Substituting Equipment, Methods, and Materials

- (1) Use the equipment, methods, or materials specified in the contract unless the engineer authorizes substitutes. If the contract does not specify equipment, methods, or materials, the contractor may use those the contractor demonstrates, to the engineer's satisfaction, to produce conforming work.
- (2) Obtain the engineer's authorization before substituting for equipment, methods, or materials specified in the contract. Submit a written request to the engineer describing the equipment, methods, or materials proposed and the reasons for the change. The engineer's authorization of a substitution does not relieve the contractor of the obligation to produce work conforming to the contract as specified in [105.3.1](#).
- (3) If after use of substituted equipment, methods, or materials, the engineer finds the work nonconforming, the contractor shall complete the remaining work with the specified equipment, methods, or materials. The nonconforming work is subject to the provisions of [105.3.2](#).
- (4) The department will pay for a substitute made under 108.8 at the contract price for the original work. The department will not extend contract time for a substitute made under 108.8, except for time resulting from a cost reduction incentive as provided in [104.10](#).

108.9 Contract Time for Working Day, Calendar Day, and Completion Date Contracts

108.9.1 General

- (1) Complete all or any portion of the project called for in the contract within the time or times for completion of the contract. All time limits in the contract are crucial elements of the contract.
- (2) The proposal will specify the time for completion as a specific number of working days, calendar days, or as a given completion date.

108.9.2 Assessing Time Charges for Working Day Contracts

- (1) For working day contracts, contract time is the number of working days specified for completion. Beginning with the start of work specified in [108.2](#), the engineer will assess working days for all days except:
 1. Days excluded in 108.9.2(4).
 2. Days if one or more of the following prevent the contractor from working on the controlling item:
 - 2.1 Earthquakes and other cataclysmic phenomena of nature the contractor cannot foresee and avoid.
 - 2.2 Weather conditions.
 - 2.3 Job conditions caused by weather.
 - 2.4 Non-compensable delays as specified in Items 2 through 7 of [108.10.2.1\(3\)](#).
 - 2.5 Compensable delays as specified in Items 2 through 5 of [108.10.3\(2\)](#).

- (2) The engineer will assess working days based on the number of hours the contractor is able to work on the controlling item with full and normal efficiency. The engineer will assess working days as follows:
 - 1. Contractor can work less than 4 hours; no working day.
 - 2. Contractor can work from 4 to less than 8 hours; 1/2 working day.
 - 3. Contractor can work 8 hours or more; full working day.
- (3) The engineer will assess working days if the contractor is not performing work on the controlling item of work, and that non-performance is due to delays the contractor can foresee, control, or prevent.
- (4) The engineer will not assess working days on:
 - 1. Saturdays, Sundays, and department-specified holidays.
 - 2. Engineer-ordered suspensions for reasons other than contractor negligence or non-compliance including winter suspensions before November 16 or after March 31.
 - 3. Contract-identified, non-work days during the construction season.
 - 4. Days from November 16 through March 31.
- (5) The engineer will continue to assess working days after November 15 if the contractor has not completed the work to the stage the contract requires to be completed by November 16.
- (6) If the engineer determines that the contractor shall not work during the period from November 16 through March 31, the contractor is not entitled to claim for a delay, time extension, or other related damages.
- (7) The engineer will prepare a weekly statement showing days charged for the preceding week and days remaining on the contract. The engineer will make this statement available to the contractor in a mutually agreeable location within 5 business days after the week covered in the statement. If the contractor disagrees with the time assessed, the contractor may give notice as specified in [104.3](#).

108.9.3 Contract Time for Calendar Day Contracts

- (1) For calendar day contracts, contract time is the number of calendar days specified for completion, including Saturdays, Sundays, and department-specified holidays, counted from the starting date specified in [108.2](#). Contract time includes contract-identified non-work days during the construction season, but excludes contract-identified winter suspension periods.

108.9.4 Contract Time for Completion Date Contracts

- (1) For completion date contracts, contract time begins with the start of work as specified in [108.2](#) and concludes on the specified completion date. Complete the contract by that date.

108.10 Determining Contract Time Extensions and Payment for Excusable Delays

108.10.1 General

- (1) The department may extend contract time by contract change order. The department will only extend contract time if an excusable delay affects the controlling item of work. Excusable delays are unforeseen and unanticipated delays not resulting from the contractor's fault or negligence. Provide documentation and schedule updates to support requested time extensions as specified:
 - 1. In [108.4.2.4](#) for bar chart progress schedules.
 - 2. In [108.4.3.5](#) for RBC progress schedules.
 - 3. In [108.4.4.6](#) for CPM progress schedules.
- (2) The department may choose not to consider time extensions for delays unless the contractor notifies the engineer as specified in [104.3](#) and updates the schedule. The engineer will evaluate the facts, pay adjustment, and time extension for the delay. The engineer's findings are final and conclusive.

108.10.2 Excusable, Non-Compensable Delays

108.10.2.1 General

- (1) Non-compensable delays are excusable delays that are not the contractor's or the department's fault. The engineer will not pay for the delay costs listed in [109.4.7](#) for non-compensable delays.
- (2) For non-compensable delays under calendar day and completion date contracts, the engineer will extend contract time if the conditions specified in 108.10.1 are met. The department will relieve the contractor from associated liquidated damages, as specified in [108.11](#), if the engineer extends time under [108.10.1](#).

(3) The following are non-compensable delays:

1. Delays due to earthquakes, other cataclysmic phenomena of nature the contractor cannot foresee and avoid, severe weather as specified in 108.10.2.2, or job conditions caused by recent weather.
2. Extraordinary delays in material deliveries the contractor or their suppliers cannot foresee and forestall resulting from strikes, lockouts, freight embargoes, governmental acts, or sudden disasters.
3. Delays due to acts of the government, a political subdivision other than the department, or the public enemy.
4. Delays from fires or epidemics.
5. Delays from strikes beyond the contractor's power to settle that are not caused by improper acts or omissions of the contractor, their subcontractors, or their suppliers.
6. Delays caused by non-completion of work by utilities or other third parties, if the contract does not specify a number of days or a completion date for that utility or third party work.
7. Altered quantities as specified in [109.3](#).

108.10.2.2 Extension of Contract Time for Severe Weather

(1) The engineer will award a time extension for severe weather on calendar day and completion date contracts. Submit a request for severe weather days if the number of adverse weather days, as defined in [101.3](#), exceeds the anticipated number of adverse weather days tabulated below.

TOTAL ANTICIPATED ADVERSE WEATHER DAYS FOR EACH CALENDAR MONTH^[2]

Jan: 31 ^[1]	Feb: 28 ^[1]	Mar: 31 ^[1]	April: 5	May: 4	June: 4	July: 3	Aug: 3
Sep: 4	Oct: 5	Nov 1 thru 15: 2	Nov 16 thru 30: 15 ^[1]	Dec: 31 ^[1]			

^[1] Includes an anticipated winter suspension from November 16 through March 31.

^[2] The number of days will be modified in the special provisions for year-round and painting contracts.

- (2) Submit the request to the engineer at the end of the month. Indicate the number of adverse weather days that occurred during that month. Provide progress schedule documentation to show that the controlling item of work was delayed. Show that the delay was beyond the control of the contractor. The engineer will assess the contractor's submittal and indicate how many adverse weather days are confirmed.
- (3) For each calendar month, the engineer will grant a severe weather day for each confirmed adverse weather day that exceeds the number of anticipated adverse weather days shown in 108.10.2.2(1). When the contractor requests severe weather days, the engineer will give the contractor a monthly written statement showing the number of days credited for severe weather. At the end of the project, the engineer will extend time on calendar day and completion date contracts for the cumulative number of severe weather days credited each month.

108.10.3 Excusable Compensable Delays

- (1) Compensable delays are excusable delays that are due to the department's actions or lack of actions, or determined by judicial proceeding to be the department's sole responsibility. The engineer will grant a time extension for a compensable delay if the conditions specified in [108.10.1](#) are met.
- (2) The following are compensable delays:
 1. A contract change for revised work as specified for extra work under [104.2.2.1](#), for a differing site condition under [104.2.2.2](#), or for significant changes in the character of the work under [104.2.2.4](#).
 2. A contract change for an engineer ordered suspension under [104.2.2.3](#).
 3. The unexpected discovery of human remains, an archeological find, or historical find consistent with [107.25](#).
 4. The unexpected discovery of a hazardous substance consistent with [107.24](#).
 5. The non-completion of work that utilities or other third parties perform, if the contract specifies a number of days or a completion date for that utility or third party work. For delays covered under Trans 220 of the Wisconsin administrative code, the contractor must seek recovery of delay costs from the utility.
- (3) For a compensable delay or a time extension, the department will relieve the contractor from associated liquidated damages under [108.11](#), and will pay the contractor for delay costs determined as follows:
 1. Adjust the contract price as specified in [109.4.2](#) through [109.4.5](#) for delays under item 1 of 108.10.3(2).
 2. Adjust the contract price as specified in [109.4.7](#) for delays under items 2 through 5 of 108.10.3(2).

108.11 Liquidated Damages

- (1) If the contractor does not complete the work within the contract time or within the extra time allowed under engineer-granted time extensions, the department will assess liquidated damages. The department will deduct a specified sum from payments due the contractor for every calendar day on calendar day contracts and completion date contracts, or for every working day on working day contracts, that the work remains uncompleted.
- (2) This deducted sum is not a penalty but is a fixed, agreed, liquidated damage due the department from the contractor by reason of inconvenience to the public, the added cost of engineering and supervision, maintenance of detours, and other items that have caused an expenditure of public funds resulting from the contractor's failure to complete the work within the contract time.
- (3) Unless modified in the special provisions, the department will assess the following daily liquidated damages. The values shown reflect only the cost of engineering and supervision.

LIQUIDATED DAMAGES			
ORIGINAL CONTRACT AMOUNT		DAILY CHARGE	
FROM MORE THAN	TO AND INCLUDING	CALENDAR DAY	WORKING DAY
\$0	\$100,000	\$180	\$360
\$100,000	\$300,000	\$295	\$590
\$300,000	\$500,000	\$480	\$960
\$500,000	\$1,000,000	\$665	\$1330
\$1,000,000	————	\$990	\$1980

- (4) If the engineer allows the contractor to continue and finish the work or any part of it after the contract time expires, the department waives no rights under the contract.

108.12 Terminating the Contract for Default

- (1) The engineer, after giving written notice to the contractor and the contractor's surety, may take the prosecution of the work out of the hands of the contractor or the contractor's surety, or both, for one or more breach of the contract the contractor commits, as follows:
 1. Failing to begin the work under the contract within the time specified.
 2. Failing to perform the work with sufficient workers, equipment, or materials to complete the work within the specified time.
 3. Failing to complete the contract within the contract time specified, as extended by the engineer.
 4. Performing the work unsuitably, or not obeying an engineer directive to remove and replace or otherwise correct unacceptable work.
 5. Discontinuing the prosecution of the work before completion without the engineer's permission.
 6. Failing to resume work that the engineer discontinued within a reasonable time after notice to do so.
 7. Insolvency or bankruptcy, or committing an act of bankruptcy or insolvency.
 8. Allowing a final judgment against the contractor to stand unsatisfied for a period of 48 hours.
 9. Making an assignment for the benefit of creditors.
 10. Failing to comply with the provisions of the contract relative to hours of labor, wages, equal opportunity, character and classification of workers employed.
 11. Failing to acquire or maintain the required insurance.
 12. Failing to carry on the work in an acceptable manner.
- (2) The engineer will give the contractor and the contractor's surety written notice specifying the delay, neglect, or default and the action required. If the contractor or the contractor's surety, within a period of 10 calendar days after that notice, fails to proceed satisfactorily in compliance therewith, the department then has full power and authority to take the work out of the hands of the contractor or the contractor's surety, or both; to use all suitable materials and equipment on the project; or to enter into contract, or use other methods that the department requires to complete the work.
- (3) If the department takes over the incomplete work under 108.12, the department will deduct all additional costs and damages and the costs and charges of completing the work under contract from payments due the contractor. If the total of those damages, costs, and charges is less than the sum that would have

been payable under the contract if the contractor had completed the work, then the contractor is entitled to receive the difference subject to all claims for liens thereon that may be filed with the department. If that total exceeds the sum that would have been payable under the contract, the department will consider the contractor and the contractor's surety liable, and the contractor and the contractor's surety shall pay to the department the amount of that excess.

- (4) The department will not relieve the contractor and the contractor's surety of the liability for the assessment of liquidated damages under [108.11](#) because of the contractor's default.
- (5) The rights and remedies of the department are in addition to all other rights and remedies provided by law or under the contract and the bonds.
- (6) If, after the engineer gives notice of default as specified in 108.12(1), it is determined that the contractor was not in default, the rights and obligations of the parties are the same as if the notice of termination had been issued as specified in [108.13](#).
- (7) If a court finds the department's default of the contractor under 108.12 to be legally improper, the department will treat the contract as if the department had terminated the contractor for convenience as specified in [108.13](#). The department will pay the contractor as specified in [108.13](#).

108.13 Terminating the Contract for Convenience of the Department

- (1) The department may terminate the contract or any part of the contract for reasons beyond the control of the department or contractor after determining that termination is in the department's or the public interest. Reasons for termination include, but are not limited to, one or more of the following:
 - 1. A national emergency that creates a shortage of materials, labor, or equipment by: reason of war conditions involving the United States; reason of orders of the federal government or its duly authorized agencies; or executive orders with respect to prosecution of war or national defense.
 - 2. Orders from duly constituted authorities relating to energy conservation.
 - 3. An injunction or restraining order obtained by a citizen's action alleging violations of 42 U.S.C. 4331-4332, 23 U.S.C. 138, or public law 91-646.
- (2) The department will deliver to the contractor a termination notice specifying the extent of termination and the effective date.
- (3) Upon receipt of a termination notice, do not proceed with the affected bid items unless directed to do so in that notice. Complete all bid items specified in the termination notice. That work includes punch list items and all work necessary to ensure the safety of the public, to properly secure work already constructed or partially constructed, and to secure the project site. Perform this work, which may include bid items not in the original contract, the contract specifies. The contract is sufficiently complete upon completion and acceptance of all bid items specified in the termination notice, except punch list items. After completion of the punch list items and all contract-required documents, the department will terminate the contract by issuing a final certificate and payment. The department reserves the right to declare in default a contractor who does not carry out the conditions of a termination for convenience.
- (4) If the department orders termination of the contract for convenience, the department will pay for all completed bid items as of that date at the contract price. The department will pay for partially completed bid items at agreed prices or by force account methods specified in [109.4.5](#) provided, however, that that payment does not exceed the contract price for the bid item under which the work was performed. The department will pay for bid items that are eliminated by the termination only to the extent provided in [109.5](#). The department will pay for new items, if any, at agreed prices or paid for by force account methods specified in [109.4.5](#).
- (5) The department may allow the contractor to purchase materials that the department obtained for the work but that have not been incorporated into the work at actual cost delivered to a designated location or otherwise disposed of as mutually agreed.
- (6) The department may, at the department's option, purchase unused materials that the contractor has obtained and that the department has inspected, tested, and accepted, at the points of delivery as the department designates and at a cost shown by receipted bills or other proper evidence.
- (7) If the engineer directs, the contractor shall promptly remove equipment and supplies from the project site or other department property. If the contractor does not remove the equipment and supplies as directed, the engineer may do so at the contractor's expense.

- (8) Within 60 calendar days of the effective termination date, submit claims for additional costs actually incurred. Do not include claims for loss of anticipated profits on work not performed. The contractor may claim one or more of the following:
1. Costs for reasonable idle equipment time or mobilization efforts.
 2. Bidding and project investigative costs.
 3. Overhead expenses attributable to the terminated project.
 4. Subcontractor costs not otherwise paid for.
 5. Actual idle labor cost if work is stopped before the termination date.
 6. Guaranteed payments for private land usage as part of the original contract.
- (9) Make cost records available to the department to the extent necessary to determine the validity and amount of each item claimed.
- (10) The department will not relieve the contractor of contractual responsibilities for the work completed. The department does not relieve the contractor's surety of its obligations for and concerning a just claim arising from work performed due to a termination of the contract.

108.14 Terminating the Contractor's Responsibility

- (1) The contractor's responsibilities are terminated, except as set forth in the contract bond and specified in [107.16](#), if the following conditions are met:
1. The contractor has completed all contract work.
 2. The department has approved and accepted the project as specified in [105.11.2.4](#).
 3. The department has paid the final estimate.

SECTION 109 MEASUREMENT AND PAYMENT

109.1 Measurement of Quantities

109.1.1 General

- (1) The engineer will use the US standard system to measure all work completed under the contract. The engineer will determine quantities of materials the contractor furnishes and work the contractor performs using measurement methods and computations conforming to standard engineering practice, modified to meet department requirements. The engineer will document these measurements using department procedures.
- (2) The engineer will measure the work as the contract measurement subsection for individual items specifies. The department will measure the actual quantities of work the contractor acceptably completes and make final payment based on those actual measured quantities except as follows:
 1. If the measurement subsection for a bid item specifically restricts the quantity measured for payment or allows for use of conversion factors.
 2. If the engineer and contractor execute a written supplemental contract agreement stating that contract quantities for specific bid items or portions of bid items substantially agree with their actual quantities, the department will pay for those contract quantities without measurement. That payment is full compensation for those bid items, or portions of bid items, as specified in [109.2](#).
 3. If the engineer executes a contract change order modifying the method of measurement for specific bid items, the engineer will measure the quantities of applicable bid items for payment using the change order methods.
 4. If the engineer, under [105.3.1\(2\)](#), approves a contractor requested plan dimension change between US standard and SI metric dimensions, the engineer will measure whichever of the following is less:
 - Actual quantities constructed.
 - Quantities derived from the original plan dimensions.
 5. For substitutions made under [106.2.3](#) between US standard and SI metric products, the engineer will measure the actual quantities of the substitute products using the original contract measuring system.

109.1.2 Area

- (1) If the contract designates payment for a measured area, the engineer will measure the length and width of the area actually constructed within engineer-designated limits, or the final dimensions measured along the surface of the completed work within the neat lines the plans show or the engineer designates. The engineer will use the method or combination of methods of measurement that reflect, with reasonable accuracy, the actual surface area of the finished work as the engineer determines.
- (2) If the contract allows, the engineer may weigh or determine a volume and convert to area for payment. The engineer will determine the weight-to-area or volume-to-area conversion factors. The engineer and contractor must agree on the conversion factor before the engineer converts a pay quantity.

109.1.3 Volume

- (1) For material specified for measurement by volume in the vehicle, haul the material in engineer-approved vehicles. Ensure that the vehicle body type allows for ready and accurate measurement of the contents.
- (2) The engineer will determine the approved capacity of vehicles to the nearest 1/10 cubic yard (0.1 m³). Unless all department-approved vehicles on a job have the same capacity, mark each vehicle with a plainly legible identification mark showing the approved capacity. Do not change capacity markings without the engineer's consent.
- (3) The engineer will measure the material in the vehicle at the point of delivery. The engineer will make no adjustment for the settlement of material during transit. The engineer may reject loads not hauled in department-approved vehicles.
- (4) If the contract allows, the engineer may weigh material and convert to a volume for payment. The engineer will determine the weight to volume conversion factors. The engineer and contractor must agree on the conversion factor before the engineer converts a pay quantity.

109.1.4 Weight

- (1) For aggregates and asphaltic mixtures specified for measurement by weight, weigh the material on platform scales or other engineer-approved scales. Include the cost to furnish scales in the bid price. Furnishing scales is incidental to the work. Use scales that the engineer has tested and determined to be satisfactory, or ensure that authorized testing firms or agencies test the scales as often as the engineer deems necessary to ascertain their accuracy.

- (2) If weighing materials in the hauling vehicle, check gross weights and determine the vehicle tare weight whenever the engineer directs.
- (3) If the contract allows, the engineer may measure the volume of material and convert to weight for payment. The engineer will determine the volume to weight conversion factors. The engineer and contractor must agree on the conversion factor before the engineer converts a pay quantity.

109.2 Scope of Payment

- (1) The department will use the US standard unit prices shown in the schedule of items to pay for the work.
- (2) The department will pay for the quantity of work acceptably completed and measured for payment as the measurement subsection for each bid item specifies. Within the payment subsections provide means to furnish and install the work complete and in-place. Payment is full compensation for everything required to perform the work under the applicable bid items including, but not limited to, the work elements listed in the payment subsection. Payment also includes all of the following not specifically excluded in that payment subsection:
 1. Furnishing and installing all materials as well as furnishing the labor, tools, supplies, equipment, and incidentals necessary to perform the work.
 2. All losses or damages, except as specified in [107.14](#), arising from one or more of the following, until the engineer makes final acceptance:
 - The nature of the work.
 - The action of the elements.
 - Unforeseen difficulties encountered during prosecution of the work.
 3. All insurance costs, expenses, and risks connected with the prosecution of the work.
 4. All expenses incurred because of an engineer-ordered suspension, except as specified in [104.2.2.3](#).
 5. All infringements of patents, trademarks, or copyrights.
 6. All other expenses incurred to complete and protect the work under the contract.
- (3) The department may withhold payments due under the contract until the contractor proves to the department that the contractor has paid for all labor and materials used in the work.

109.3 Payment for Altered Quantities

- (1) If the measured quantity for a bid item varies from the quantity given in the proposal, the department will make payment at the original contract bid price for the quantity measured as specified in [109.1.1\(2\)](#). The department will adjust payment for revisions in plans or quantities of work requiring contract change orders as specified in [104.2](#).
- (2) The department will not pay the contractor for loss of expected reimbursement or anticipated profits suffered or claimed by the contractor. The department will not make revisions to the contract bid prices except as specified in [104.2](#).

109.4 Price Adjustments for Contract Revisions

109.4.1 General

- (1) If the department revises the contract under [104.2](#), the department will adjust the contract price using the sequence specified in [109.4.2](#) through [109.4.5](#). This price adjustment includes payment for performing the revised work, delay costs, and all other associated costs deemed reasonable by the engineer and not expressly precluded in [109.4.6](#). The department may, at anytime, direct the contractor to perform all or part of the revised work under force account.
- (2) If a contract revision includes a time adjustment for compensable delays under items 2 through 5 of [108.10.3\(2\)](#), the department will adjust the contract price for delay costs as specified in [109.4.7](#).

109.4.2 Contract Bid Prices

- (1) Before proceeding to another pricing method, the engineer will attempt to price revised work using contract bid prices.

109.4.3 Minor Contract Revisions Not Covered by Contract Bid Prices

- (1) The engineer and contractor may agree on the scope of, and a lump sum price for, work done under a contract revision conforming to the following conditions:

1. The contract revision is not covered by contract bid prices.
 2. The contract revision is limited in scope.
 3. The absolute value of the revision will not exceed \$5000. Determine the absolute value of the revision by summing the absolute dollar value of all deletions and the absolute dollar value of all additions.
- (2) This agreed lump sum price includes payment for performing the revised work, delay costs, and all other associated costs. Do not proceed with the revised work without agreement. If the contractor and engineer do not agree on a lump sum price, the engineer will negotiate a price under [109.4.4](#) or have the contractor proceed under force account as specified in [109.4.5](#).

109.4.4 Negotiated Prices

- (1) The engineer and contractor will negotiate the price of a contract revision for one or more of the following:
 1. Adjustments in contract bid prices are necessary due to a significant change as specified in [104.2.2.4](#).
 2. The engineer and contractor cannot agree on a revised price under [109.4.2](#) or [109.4.3](#).
- (2) Provide an estimate of the proposed unit prices or lump sum price for the contract revision. Include the cost of performing the revised work, delay costs, all other associated costs, plus a reasonable allowance for profit and applicable overhead. The engineer may request that the contractor justify the estimate by providing one or more of the following:
 1. Labor requirements by trade in hours for each task.
 2. Equipment costs and time requirements.
 3. Material costs.
- (3) Provide the justification within 5 business days after the department's request. The department will respond to the estimate within 5 business days after receipt of the contractor's justification. The department and the contractor can mutually agree to extend these 5-day requirements.
- (4) 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.

109.4.5 Force Account

109.4.5.1 General

- (1) The engineer may direct the contractor to perform the revised work under force account. Submit a written proposal for the work including the planned equipment, materials, labor, and work schedule.
- (2) The department will pay the contractor as specified in [109.4.5.2](#) through [109.4.5.6](#), as full compensation for performing the force account work, delay costs, and all other associated costs. At the end of each workday, the contractor's representative and the inspector shall compare records of the work done under force account. The department will make no force account payment before the contractor submits an itemized statement of the costs for that work.
- (3) Provide the following content in itemized statements for all force account work:
 1. Name, classification, date, daily hours, total hours, rate, and amount for all labor.
 2. Designation, dates, daily hours, total hours of actual operation and stand-by operation, rental rate, and amount for each unit of equipment, or the applicable hourly equipment expense rate for each truck or other unit of machinery and equipment. Include the manufacturer's name or trademark, model number, and year of manufacture with the designation.
 3. Quantities of materials and prices.
 4. Transportation charges on materials, free on board (f.o.b.) at the job site.
 5. Cost of property damage, liability, and workers compensation insurance premiums; unemployment insurance contributions; and social security tax.
 6. Documentation showing payment for all invoiced work.
 7. If materials are taken from contractor's stock and original receipted invoices for the materials and transportation charges cannot be provided, provide an affidavit and certify the following:
 - The materials were taken from the contractor's stock.
 - The quantity shown was actually used for the force account work.
 - The price and transportation costs represent the actual cost to the contractor.

- (4) The engineer will review all rates and costs submitted by the contractor. The department will only pay for costs the engineer approves.

109.4.5.2 Labor

- (1) The department will pay the contractor's labor costs, at prevailing wage rates or at wage rates previously agreed upon with the department in writing, for personnel directly involved in producing and supervising the force account work. The department will only pay for hours that personnel are actually engaged in force account work. The department will also reimburse the contractor for the actual costs paid to, or on behalf of, workers for subsistence and travel benefits, health and welfare benefits, pension fund benefits, or other contractor-paid benefits. The department will pay an additional 35 percent markup of these wages and benefits.
- (2) The department will pay no part of wages or benefits for personnel connected with the contractor's forces above the classification of foreman and having only general supervisory responsibility for the force account work.

109.4.5.3 Insurance

- (1) The department will pay the contractor's actual costs for property damage, liability, and workers compensation insurance premiums, unemployment insurance contributions, and social security taxes on force account work. The department will pay an additional 15 percent markup of these costs. The contractor shall furnish satisfactory evidence of the rates actually paid.

109.4.5.4 Materials

- (1) 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 of these costs. If the contractor uses materials from the contractor's stock, the department and the contractor will agree on the price. Do not incorporate materials into the work without agreement.
- (2) The department reserves the right to furnish materials as it deems appropriate. Make no claims for costs, overhead, or profit on materials that the department provides.

109.4.5.5 Equipment

109.4.5.5.1 General

- (1) 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 for equipment only during the hours that it is operated. The department will pay for non-operating hours at the stand-by rate as specified in [109.4.5.5.3](#). Report equipment hours to the nearest 1/2-hour.
- (2) The department will pay for use of contractor-owned equipment the engineer approves for force account work at published rates. The department will pay the contractor expense rates, as modified in 109.4.5.5, given in the Rental Rate Blue Book for Construction Equipment (blue book) published by Primedia Information, Inc. Base all rates on the blue book rental rate chapter revisions effective on April 1 for all equipment used from that April 1 through the following March 31.
- (3) For each piece of equipment the contractor uses, whether bought or rented, the contractor shall provide the engineer with the following information:
1. Manufacturer's name.
 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.

- (4) The contractor shall provide for the engineer's confirmation, 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.
- (5) The department will not pay rental for tools or equipment with a replacement value of \$500 or less.
- (6) 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.
- (7) For equipment not listed in the blue book, provide an expense rate and furnish cost data to support that rate. Obtain the engineer's written approval for the expense rate before using that equipment on force account work.

109.4.5.5.2 Hourly Equipment Expense Rates (Without Operators)

- (1) The contractor shall determine, and the department will confirm, hourly equipment expense rates as follows:

$$\text{HEER} = [\text{RAF} \times \text{ARA} \times (\text{R}/176)] + \text{HOC}$$

Where:

HEER = Hourly equipment expense 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

- (2) The hourly operating cost shown in the blue book represents all costs of equipment operation, including fuel and oil, lubrication, field repairs, tires, expendable parts, and supplies.

109.4.5.5.3 Hourly Equipment Stand-By Rate

- (1) For equipment that is in operational condition and is standing-by with the engineer's approval, the contractor shall determine, and the department will confirm, the hourly stand-by rate as follows:

$$\text{HSBR} = \text{RAF} \times \text{ARA} \times (\text{R}/176) \times (1/2)$$

Where:

HSBR = Hourly stand-by 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

- (2) The department will limit payment for stand-by to 10 hours or less per day up to 40 hours per week. The department will not pay the contractor for equipment that is inoperable due to breakdown. The department will not pay for idle equipment if the contractor suspends work or if the contractor is maintaining or repairing the equipment.

109.4.5.5.4 Hourly Outside-Rented Equipment Rate

- (1) If the contractor rents or leases equipment from a third party for force account work, the contractor shall determine, and the department will confirm, the hourly outside-rented equipment rate as follows:

$$\text{HORER} = \text{HRI} + \text{HOC}$$

Where:

HORER = Hourly outside-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

HOC = Hourly operating cost shown in the blue book

109.4.5.5.5 Owner-Operated Equipment

- (1) For rental of equipment owned and operated by persons other than the contractor or their subcontractors, the department will pay the contractor based on the actual paid invoice. Provide an invoice that includes all costs for furnishing and operating the equipment. Obtain the engineer's written approval of the rental rates before starting the force account work.
- (2) The department will allow the contractor to add a markup on the invoice for owner-operated equipment. Determine the markup in the same manner as specified in [109.4.5.6](#) for subcontractors.

109.4.5.5.6 Moving of Equipment

- (1) The department will pay the contractor at the hourly equipment expense rate, as specified in [109.4.5.5.2](#), for time required to move needed equipment under its own power to the location of the force account work and to return it to its original location on the project. The department will pay the contractor at the hourly equipment expense rate, as specified in [109.4.5.5.2](#), for the transporting vehicle only if it is transporting equipment to, from, and within the project.
- (2) The department will pay the contractor for actual freight costs of equipment moved by commercial carrier.

109.4.5.6 Force Account Work by Subcontractors

- (1) If a subcontractor performs force account work, the department will allow the contractor a markup on work the subcontractor performs as follows:
 1. Use a markup of 10 percent for the first \$10,000 of work.
 2. Use a markup of 2 percent for work in excess of \$10,000.

109.4.6 Non-Allowable Charges for Adjustment of Contract Prices

- (1) Whether contract revision price adjustments are based on contract bid prices, agreed lump sum prices, negotiated prices, or force account, the department will not reimburse the contractor for the following:
 1. Profit in excess of that specified in [109.4.2](#) through [109.4.5](#).
 2. Loss of anticipated profit.
 3. Home office overhead.
 4. Consequential damages, including loss of bonding capacity, loss of bidding opportunities, and insolvency.
 5. Indirect costs.
 6. Attorneys fees, claims preparation expenses, or costs of litigation.
 7. Interest.

109.4.7 Price Adjustments for Delay Costs

109.4.7.1 General

- (1) For a compensable delay under items 2 through 5 of [108.10.3\(2\)](#), the department will pay for the costs specified here in [109.4.7.2](#). The department will not pay for non-allowable charges specified in [109.4.6](#) nor duplicate payment made under [109.4.2](#) through [109.4.5](#).
- (2) The department will only pay the contractor for costs the contractor actually incurs. The department will make no payment for delay costs before the contractor submits an itemized statement of those costs. Provide the content specified in [109.4.5.1\(3\)](#), for the applicable items, in this statement.

109.4.7.2 Allowable Delay Costs

109.4.7.2.1 Extended Field Overhead

- (1) The department will pay the contractor for extended field overhead costs that include costs for general field supervision, field office facilities and supplies, and for maintenance of field operations.
- (2) General field supervision costs include, but are not limited to, field supervisors, assistants, watchman, clerical, and other field support staff. Compute these labor costs as specified in [109.4.5.2\(1\)](#). For salaried personnel, calculate the daily wage rate actually paid by dividing the weekly salary by 5 days per week.
- (3) Field office facility and supply costs include, but are not limited to, field office trailers, tool trailers, office equipment rental, temporary toilets, and other incidental facilities and supplies. Compute these costs on a calendar-day basis using actual costs incurred due to the delay to provide these services.

- (4) Maintenance of field operations costs include, but are not limited to, telephone, electric, water, and other similar expenses. Compute these costs on a calendar-day basis using actual costs incurred due to the delay to maintain these services.

109.4.7.2.2 Extended Labor

- (1) Compute labor costs during delays as specified in [109.4.5.2](#) for all non-salaried personnel remaining on the project as required under collective bargaining agreements or for other engineer-approved reasons.

109.4.7.2.3 Escalated Labor

- (1) To receive payment for escalated labor, 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 [109.4.5.2](#).

109.4.7.2.4 Equipment Stand-By or Equipment Demobilization

- (1) The department will pay the contractor the stand-by rate calculated in [109.4.5.5.3](#) for equipment, other than small tools, that must remain on the project during delays. The department will pay the contractor's transportation costs to remove and return equipment not required on the project during delays.

109.4.7.2.5 Materials Escalation or Material Storage

- (1) 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 material due to a delay.

109.5 Eliminated Items

- (1) If the department partially eliminates or completely eliminates a bid item as specified in [104.2.2.5](#), the department will pay contractor costs incurred due to that elimination. The department will pay a fair and equitable amount covering all costs incurred as of the date the work was deleted. Immediately submit a certified statement covering all money expended for the eliminated bid item.
- (2) The department will execute a contract change order for the following costs related to an eliminated bid item:
 - 1. Preparation expenses defined as follows:
 - If preparation for the eliminated bid item has no value to other contract bid items, the department will reimburse the contractor in full for that preparation.
 - If preparation for work on the eliminated bid item would ordinarily be distributed over other contract bid items, the department will prorate reimbursement based on the value of the eliminated bid item compared to the total value of all associated contract bid items.
 - 2. All restocking and cancellation charges.
 - 3. A reasonable allowance for applicable overhead.
- (3) If the department partially eliminates or completely eliminates a bid item, the department may pay for, and take ownership of, materials or supplies the contractor has already purchased.

109.6 Progress Payments

109.6.1 General

- (1) The department will first prepare a progress payment estimate as described in [109.6.3](#), and then will make a progress payment based on the engineer's estimate of the quantities of work completed. Payment will be at the contract or agreed unit or lump sum prices. The department may suspend progress payments if the contractor does not comply with the engineer's directions as the contract specifies. The department will notify the contractor immediately whenever progress payments are suspended.
- (2) The department will restrict progress payments, as specified in [108.4](#), until the engineer accepts the contractor's progress schedule. Progress payment restrictions are specified in [108.4.2.1\(5\)](#) for bar chart schedules, in [108.4.3.2\(5\)](#) for RBC schedules, and in [108.4.4.3\(6\)](#) for CPM schedules.
- (3) The department's payment of an estimate before final acceptance of the work does not constitute the department's acceptance of the work, and does not relieve the contractor of responsibility for:
 - 1. Protecting, repairing, correcting, or renewing the work.
 - 2. Replacing all defects in the construction or in the materials used in the construction of the work under the contract, or responsibility for damage attributable to these defects.

- (4) The contractor is responsible for all defects or damage that the engineer may discover on or before the engineer's final inspection and acceptance of the work. The engineer is the sole judge of these defects or damage, and the contractor is liable to the department for not correcting all defects or damage.
- (5) The department will take ownership of all material and work covered by progress payments. However, the contractor remains solely responsible for all materials and work covered by progress payments and for the restoration of damaged work as specified in [107.14](#). Also, by making the progress payment, the department waives no requirement, right, or term of the contract as specified in [107.16](#).

109.6.2 Frequency

- (1) The department will make 2 progress payments each month, as feasible, if the contractor is due a payment of \$1000 or more. The department may reduce this minimum payment due for contracts of \$25,000 or less.

109.6.3 Preparation of Progress Payment Estimate

109.6.3.1 General

- (1) The department will compute quantities to reflect the approximate amount of work completed, or substantially completed, under the pertinent contract bid items to the date of the progress payment estimate. The department will adjust quantities to cover contingencies and costs for finishing or maintaining the work. If the engineer bases the progress payment estimate on contract quantities, the department will adjust quantities to cover variations between the contract and final quantities.

109.6.3.1.1 Pending Contract Change Order Work

- (1) Between the times the engineer authorizes a contract change order and the department executes it, the engineer will include, in the progress payment estimate, the value of the acceptably completed change order work. The department will pay at least 90 percent of the value of the work as it is completed under an unexecuted change order. After the department executes the change order, the department will deduct payments made on the unexecuted change order work from future payments due the contractor.

109.6.3.2 Materials

109.6.3.2.1 General

- (1) The engineer may include in the progress payment estimate the value of materials that:
 - 1. Are specifically manufactured, produced, or purchased for incorporation as a permanent part of the work.
 - 2. Are delivered to the project or stored at a location off the project as specified in [106.4](#).
 - 3. Are stored separately and irrevocably assigned to the project if stockpiled at plants or fabrication sites.
- (2) The engineer will require the contractor to document costs for materials included in a progress payment estimate. Provide the required invoice, billing, title, or assignment documents including a complete material description, identification, and cost data.
- (3) If the contractor does not satisfy all vendor claims made against the contractor for materials within 30 calendar days after receiving the progress payment, the department may cancel the applicable materials payment in the next progress payment estimate.
- (4) If making progress payments for materials, the engineer will not exceed the delivered cost or contract amount for the material complete in place. The engineer will use those amounts paid for materials to reduce future payments due the contractor for completed work incorporating those materials.

109.6.3.2.2 Structural Steel

- (1) On contracts containing 250 tons (250 Mg) or more of structural steel, the engineer may also include in the progress payment estimate the value of Structural Steel Carbon or Structural Steel HS, or both, to be used in the completed work and that has been delivered to the fabricator.
- (2) In addition to the information required in [109.6.3.2.1](#), provide the weights, dimensions, and heat and unit numbers.
- (3) Store the structural steel separately. Use stored structural steel only for fabrication of structural components to be used on the contract.
- (4) Present acceptable evidence indicating satisfactory fabrication of structural steel. The engineer may include, in the estimate prepared for progress payment, the value of this fabricated material, determined by multiplying the total unit weight of the material by 80 percent of the contract unit price.

109.6.3.3 Retainage

- (1) The department will withhold retainage from progress payment estimates for liquidated damages and claims including the following:
 1. To provide for recovery of liquidated damages assessable against the contract under [108.11](#).
 2. To cover claims against the contract filed with the department under chapter 779 of the Wisconsin statutes.
 3. To provide for recovery of damage and tort claims assessable against the contract under [107.12](#).
- (2) In addition to the above retainage, the department will retain 5 percent of each estimate that exceeds 75 percent of the original contract value until the department finally accepts the work. When the contractor substantially completes the work under the contract or upon completion and acceptance of the work, and pending final payment, the engineer may choose to reduce the amount retained.

109.7 Acceptance and Final Payment

- (1) After the department makes final acceptance of the work as specified in [105.11.2](#) and receives required document submittals and materials test reports, the engineer will submit to the contractor the semi-final estimate of the quantities for the work performed by the contractor.
- (2) Within 90 calendar days after receiving the semi-final estimate, submit to the engineer a written statement of agreement or disagreement with the semi-final estimate. For an acceptable statement of disagreement, submit an item-by-item list with reasons for each disagreement. If the contractor does not submit this written statement within those 90 days, the engineer will process the final estimate for payment. The engineer and the contractor can mutually agree to extend this 90-day submission requirement.
- (3) If the contractor submits an acceptable statement of disagreement, the department will withhold payment of the final estimate and determine the validity of the contractor's disagreement. After considering the contractor's statement, the department may revise the final estimate based on the engineer's judgment of the validity of the contractor's disagreement.
- (4) The department will make final payment within one year after the date the contractor provides the department with written confirmation of the semi-final estimate, or within one year after expiration of the 90-day period specified in 109.7(2), whichever applies. If the department does not make payment as required, the department will pay interest, compounded monthly, on the balance due at the rate specified in section 16.528(2)(a) of the Wisconsin statutes.
- (5) If the department has been notified that there are multiple claims against the amount held and the department concludes that it cannot appropriately choose between or among the conflicting claims, the department may withhold payment of the amount at issue pending resolution of those conflicts. Upon resolution of all issues affecting rights to the amount held, the department will make payment to the claimant or claimants.
- (6) The department may correct progress estimates and payments in the final estimate and payment.

109.8 No Assignment of Payments

- (1) The department will pay the contractor all payments due under the contract, or any part of the contract, as specified in section 109. The department will recognize no contractor-executed assignment or order directing payment of all, or any portion of, the funds to any other person or persons.

PART 2 EARTHWORK

SECTION 201 CLEARING AND GRUBBING

201.1 Description

- (1) This section describes cutting and disposing of trees, brush, windfalls, logs, and other vegetation occurring within the clearing limits; and removing and disposing of roots, stumps, stubs, logs, and other timber occurring within the grubbing limits.

201.2 (Vacant)

201.3 Construction

- (1) Clear and grub all areas within the clearing and grubbing limits defined as follows:
 1. Between lines 5 feet (1.5 m) outside the grading limits of roadway cuts and fills, including intercepting embankments, channels, ditches, borrow pits, and marsh or waste disposal areas.
 2. Other parts of the right-of-way the plans or special provisions designate.
 3. Designated clear zone and clear vision areas.
 4. With the engineer's approval, areas with vegetation that interferes with excavation, embankment, marsh, or waste disposal.
 5. The contractor does not have to grub the following:
 - 5.1. Areas designated for occupation by earth embankments 6 feet (1.8 m) or more in height.
 - 5.2. Areas used for marsh excavation disposal for which the State has obtained easements.
- (2) Preserve vegetation within the clearing limits as the plans show or the engineer directs. Cut off and dispose of all other trees, brush, shrubs, or other vegetation occurring within the clearing limits. Within the grubbing limits, remove debris not suitable for the roadway foundation, stumps and associated roots, logs, timber, brush, and matted roots to the following minimum depths:
 1. In cut areas, one foot (300 mm) below final subgrade.
 2. In embankment areas, one foot (300 mm) below the existing grade.
- (3) Do not remove trees and shrubs located beyond the clearing limits unless the engineer specifically authorizes their removal. If clearing where grubbing is not required, cut shrubs and brush to within 3 inches (75 mm) of the ground surface. Cut trees as nearly flush with the ground surface as is practical with tools ordinarily used for these operations.
- (4) Prevent the spread of oak wilt by treating all cut surfaces and abrasions sustained between April 1 and September 30 by healthy oak trees and saplings with a thorough application of tree paint immediately upon discovering a wound. Between these dates, also paint the cut surfaces of the stumps of all healthy oak trees and saplings immediately after cutting, whether remaining in place or grubbed.
- (5) If feasible, fell trees toward the center of the area being cleared. If this is not possible due to danger to traffic or injury to other trees, structures, or property, cut them into sections from the top down.
- (6) Do not injure or damage trees and shrubs left in place on the right-of-way. Symmetrically trim lower limbs or branches of trees left in place and overhanging the roadbed to at least 20 feet (6 m) above the finished grade. Trim using generally accepted horticultural practices.
- (7) Unless the contract specifies otherwise, the contractor owns all timber salvaged from the required clearing of right-of-way acquired by the highway authority in fee simple title, or from clearing of trees acquired by and for the public in the acquisition of easement of the right-of-way. Set aside all logs and timber greater than 4 inches (100 mm) in diameter to the extent feasible for commercial or fuel use. Do not burn or bury this material on the right-of-way or lands adjacent to the right-of-way without first making it available for commercial or fuel use. If it is not possible to dispose of this material for commercial or fuel use, dispose of the salvaged logs as specified for waste logs in 201.3(10).
- (8) Private owners holding underlying title to lands acquired or reserved for highway purposes by easement or by use have a prior right to all timber from trees standing or lying, except timber required for construction of the work, and except timber from trees acquired by and for the public in the acquisition of the right-of-way. Consult with the private owners about disposing of trees cut on their land. Remove from the right-of-way and dispose of trees, or portions of trees, claimed by the owners. Ensure that timber disposal sites are neatly constructed.

- (9) Comply with WDNR air pollution control rules prohibiting open burning of weeds, brush, logs, limbs, stumps, roots, lumber, and debris resulting from clearing and grubbing, or demolition in the Southeast Wisconsin Intrastate Air Quality Control Region. This region includes the counties of Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha; or in any other region that prohibits burning.
- (10) Dispose of stumps, roots, brush, waste logs and limbs, timber tops, and debris resulting from clearing and grubbing or occurring within the clearing and grubbing limits by burning, chipping, burying, or removing from the right-of-way.
- (11) The contractor may burn this material in one of the following ways: in the open, if allowed, or in an approved air curtain destructor, if allowed.
- (12) For disposal by open burning, pile and burn materials within the clearing limits at times and in a manner that does not injure trees or shrubs being left in place, create a nuisance, create a hazard to traffic, or cause damage to public or private property.
- (13) For disposal by mechanical chipping, recover all material as it leaves the chipping machine. Stockpile and use this material as specified for mulch under [section 627](#), dispose of it off the right-of-way, or bury it as specified in 201.3(14).
- (14) If open burning is not allowed and the engineer approves, the contractor may bury material in engineer-approved locations on the right-of-way outside the construction limits. Minimize the bulk of the material and cover it with at least one foot (300 mm) of earth. If the engineer approves, the contractor may dispose of the debris from open burning in this same manner.
- (15) Unless disposed of in another manner, dispose of material off the right-of-way according to applicable solid waste disposal regulations. Obtain written permits for this disposal from the owner of the property where placing the material, unless disposing of this material at a licensed waste disposal operation. Furnish permits, or copies of permits, to the engineer before disposal begins.
- (16) Chip, burn, or bury under not less than one foot (300 mm) of earth all elm wood consisting of trees, logs, stumps, stubs, branches, or windfalls with adhering bark, and all elm bark and debris within clearing and grubbing limits or resulting from clearing and grubbing operations.
- (17) Debark all elm logs salvaged, and all elm wood or stumps that are not disposed of by chipping, burning, or burying; and chip, burn, or bury the bark. For clearing and grubbing operations performed between April 1 and September 30, perform final disposal of elm wood, bark, or debris within 30 days. For clearing and grubbing operations performed between October 1 and March 31, perform final disposal of elm wood, bark, or debris before the succeeding May 1.
- (18) Dispose of all clearing and grubbing debris before proceeding with grading operations. If the contractor intends to burn debris but cannot secure burning permits on schedule, do not delay removing clearing debris from areas affected by other operations. While waiting to secure burning permits, pile clearing and grubbing debris beyond the limits affected by other work. Do not leave elm debris beyond the 30-day limitation specified in 201.3(17).

201.4 Measurement

201.4.1 General

- (1) The department will measure Clearing and Grubbing separately, either by the station, inch of diameter, square yard, or acre as the contract indicates.
- (2) The department will measure Clearing and Grubbing required for the excavation of channels and ditches, occurring outside the limits of the roadway clearing and grubbing. If measured by the station, the department will measure along the centerline of these channels and ditches.
- (3) The department will measure Clearing performed on marsh disposal or waste disposal areas of the right-of-way and on easements furnished by the State. If measured by the station, the department will measure along the roadway centerline.
- (4) The department will not measure incidental clearing and grubbing operations required to perform the work as follows:
 - 1. Clearing areas of light brush, shrubs, and other vegetation that the contractor can cut with a brush scythe or mowing machine.
 - 2. Clearing areas containing logs, tree roots, roots of brush, shrubs, and other vegetation having a woody structure that the contractor can remove with a rooter.

3. Clearing small trees of less than the minimum number and size specified for measurement.
4. Trimming overhanging limbs and branches to provide required clearance.
5. Clearing and grubbing borrow pits.

201.4.2 By the Station

- (1) The department will measure Clearing and Grubbing by the full 100-foot (40 m) survey station acceptably completed, measured along the roadway centerline or reference line. If 2 or more roadways occur, the department will measure clearing and grubbing along the centerline or reference line of each roadway. For divided highways, the department will extend measurement units for each roadway, in width, from 5 feet (1.5 m) outside the grading limit of that roadway to a line mid-way between the reference lines or centerlines for each roadway.
- (2) The department will only include stations with a total of 12 inches (300 mm) or more of diameter determined as specified under 201.4.3. The department will include each station conforming to this criterion as a full station.

201.4.3 By the Square Yard

- (1) The department will measure Clearing and Grubbing by the square yard acceptably completed within the designated limits. The department will calculate the horizontal area bounded by the line of trunks cut or grubbed. The department will not measure outside the right-of-way limits or acquired easements. The department will include only areas containing trees or stumps with a 3-inch (75 mm) or greater diameter. The department will determine diameters as specified under 201.4.3.

201.4.4 By the Acre

- (1) The department will measure Clearing and Grubbing by the acre acceptably completed within the designated limits. The department will calculate the horizontal area bounded by the line of trunks cut or grubbed. The department will not measure outside the right-of-way limits or acquired easements. The department will measure separate areas or isolated stands of less than 1/5 acre (0.1 ha) as 1/5 acre (0.1 ha). The department will include only areas containing trees or stumps with a 3-inch (75 mm) or greater diameter. The department will determine diameters as specified under 201.4.3.

201.4.5 By the Inch of Diameter

- (1) The department will measure Clearing and Grubbing by the inch of diameter (25 mm) acceptably completed. The department will determine tree diameter by measuring the circumference approximately 4 1/2 feet (1.4 m) above the existing ground level, but above the ground swell, and dividing by 3. The department will determine stump diameter, for stumps not resulting from the contractor's clearing operations, by computing the average diameter of the stump top. The department will include only those in-place trees or stumps with a 3-inch (75 mm) or greater diameter. The department will round circumference measurements and diameters to the nearest inch (25 mm).

201.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
201.0105	Clearing	STA
201.0110	Clearing	SY
201.0115	Clearing	ACRE
201.0120	Clearing	ID
201.0205	Grubbing	STA
201.0210	Grubbing	SY
201.0215	Grubbing	ACRE
201.0220	Grubbing	ID

- (2) Payment for Clearing and Grubbing is full compensation for the following:
 - All clearing and all grubbing required under this section and performed within the clearing and grubbing limits, as defined in [201.3\(1\)](#).
 - Handling, hauling, piling, burning, burying, trimming, chipping, wound treatment, rehandling, and disposing of waste and debris.
 - Excavations made to bury clearing and grubbing material, backfilling these excavations, and disposing of excess excavated material.

- (3) The department will pay for clearing and grubbing, ordered and performed beyond the clearing and grubbing limits, as defined in [201.3\(1\)](#), at the contract unit price if the Clearing and Grubbing bid items are in the contract, or as extra work if Clearing and Grubbing bid items are not in the contract.
- (4) The incidental clearing and grubbing described in [201.4.1\(4\)](#) is incidental to the Excavation bid items of section 205 or to other contract bid items.

SECTION 202 ROADSIDE CLEARING

202.1 Description

- (1) This section describes cutting and disposing of undesirable trees, brush, shrubs, and vegetation; removing and disposing of windfalls, logs, uprooted stumps, and rubbish; and trimming of selected trees and saplings to be saved; all within the right-of-way limits but outside the clearing limits defined in [201.3](#).

202.2 (Vacant)

202.3 Construction

- (1) Perform roadside clearing on all sections of the project the plans designate and to the limits the plans or special provisions indicate. If no limits are indicated, perform roadside clearing on all areas of the right-of-way outside the clearing limits.
- (2) Preserve all desirable and structurally sound trees, saplings, or shrubs suitable for shade or road beautification purposes unless the engineer directs otherwise. Do not injure or damage trees and saplings designated for preservation. Remove the dead material and lower branches of preserved trees as directed, to promote uniformity and proper development of shape and appearance. Trim using generally accepted horticultural practices.
- (3) Cut all undesirable trees, brush, shrubs, existing stumps, and vegetation as nearly flush with the ground surface as reasonably possible with tools ordinarily used for these operations. Avoid harming trees and saplings designated for preservation when felling undesirable trees. If unable to fell trees due to danger to traffic or injury to other trees, structures, or property, then cut them into sections from the top down.
- (4) Treat cut surfaces, abrasions, and damaged areas of healthy oak trees and saplings, and cut surfaces of stumps of these trees as specified for preventing oak wilt under [201.3\(4\)](#).
- (5) Remove windfalls, logs, uprooted stumps, and rubbish from the surface of the ground within all areas of the right-of-way included under roadside clearing operations.
- (6) Dispose of all timber, stumps, brush, waste logs and limbs, tops, and debris resulting from roadside clearing as specified in [201.3](#).

202.4 Measurement

202.4.1 General

- (1) The department will measure Roadside Clearing by the station, square yard, or acre as the contract indicates.

202.4.2 By the Station

- (1) The department will measure the Roadside Clearing (station) bid items by the full 100-foot (40 m) survey station acceptably completed, measured along the roadway centerline or reference line. If 2 or more separate roadways occur, the department will measure along the centerline or reference line of each roadway. The department will include only stations where roadside clearing is designated and performed. The department will include each station conforming to these criteria as a full station.

202.4.3 By the Square Yard

- (1) The department will measure Roadside Clearing by the square yard acceptably completed within the designated limits as calculated from horizontal measurements. The department will not measure outside the right-of-way limits or acquired easements.

202.4.4 By the Acre

- (1) The department will measure Roadside Clearing by the acre acceptably completed within the designated limits as calculated from horizontal measurements. The department will not measure outside the right-of-way limits or acquired easements. The department will measure separate areas or isolated stands of less than 1/5 acre (0.1 ha) as 1/5 acre (0.1 ha).

202.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
202.0105	Roadside Clearing (station)	STA
202.0110	Roadside Clearing	SY
202.0115	Roadside Clearing	ACRE

- (2) Payment for the Roadside Clearing bid items is full compensation for all cutting, clearing, wound treatment, and disposal of waste vegetation.
- (3) If the engineer orders the contractor to perform work specified in this section, except work required for final cleanup under [104.9](#) or paid for under the Finishing Roadway bid item, the department will pay for this work as extra work.

SECTION 203 REMOVING OLD CULVERTS AND BRIDGES

203.1 Description

- (1) This section describes wholly or partially removing or closing existing culverts and bridges, disposing of the resulting materials, or if required, salvaging and storing designated materials.

203.2 (Vacant)

203.3 Construction

203.3.1 General

- (1) Remove or close existing culverts, bridges, or parts thereof that are within the roadway and that are replaced by or interfere with the new construction. The contractor who constructs the new structure that replaces the existing facility, unless the contract specifies otherwise, shall perform this removal or closing.
- (2) If specified in the contract, remove or close existing culverts, bridges, or parts of them, beyond the roadway limits, but within the highway limits.
- (3) Leave existing culverts and bridges that are beyond the limits of the highway in place and in service unless the contract specifies otherwise.
- (4) Upon removal, culverts, bridges, or parts of them, become the property of the contractor, unless designated in the contract as salvageable. If the contractor removes, but does not replace entrance pipes from private property, the contractor must offer these pipes to the property owners before claiming them.

203.3.2 Breaking Down and Removing

- (1) Remove those parts of an existing structure that interfere with new construction regardless of location.
- (2) Except as specified below for closing culverts, remove the entire top slab of box culverts and the entire superstructure of all other culverts and bridges designated for removal. Completely remove existing piles, cribs, or other timber construction that are within the limits of new embankments, or remove these structures to an elevation at least 2 feet (0.6 m) below finished ground line. Remove sidewalls or substructure units in water to an elevation no higher than the elevation of the natural stream or lake bed, or, if grading the channel is required under the contract or the plans, to the proposed finished grade of the stream or lake bed. Remove sidewalls or substructure units not in water down to at least 2 feet (0.6 m) below natural or finished ground line.
- (3) If removing a bridge deck to construct a new deck, protect the work as specified in [107.14](#). Remove decks on prestressed concrete girders using a hydraulic shear or other engineer-approved equipment. The engineer will determine if prestressed concrete or steel girders are structurally damaged during deck removal. Remove and replace or otherwise repair damage as required to structurally restore the girders. Bear all restoration expenses, including engineering costs. Have a registered professional engineer analyze the effect of damage to the bridge, make recommendations, and prepare signed, sealed, and dated structural details for the proposed restoration. Submit the structural details to the department and the design engineer of record. The department and design engineer of record will jointly accept or reject the proposed restoration within 3 business days. Do not begin restoration work without the department's acceptance. The engineer will not extend contract time to complete this work.
- (4) During deck removal operations, do not damage the existing bar steel reinforcement to be incorporated in the new work, and thoroughly clean, realign, and retie reinforcement if necessary. Minimize debris falling onto water surfaces and wetlands as the contract specifies in [107.18](#) or in the special provisions. Also, minimize debris falling on the ground and roadway.
- (5) Do not use equipment, facilities, or methods that might damage members, portions of the structure to be preserved, or adjacent construction. Before starting new work, complete all blasting or other operations that might endanger new work. If incorporating portions of existing culverts or bridges in the new work, remove the portions not being saved in a manner that leaves the remainder of the structure undamaged. Repair all damage to the remaining portion at no expense to the department.
- (6) If extending or incorporating existing culverts and bridges in the new work, remove only those parts of the existing structure as necessary to provide a proper connection to the new work. Saw, chip, or trim the connecting edges to the required lines and grades without weakening or damaging the remaining part of the structure. During concrete removal, do not damage reinforcing bars left in place as dowels or ties incorporated into the new work.
- (7) Remove pipe culverts designated for salvage in a manner that prevents damage to the culverts.

- (8) Dismantle steel structures or parts of steel structures designated for salvage in a manner that avoids damage to the members. If the contract specifies removing the structure in a manner that leaves it in a condition suitable for re-erection, matchmark all members with durable white paint before dismantling. Mark all pins, bolts, nuts, loose plates, etc., similarly to indicate their proper location. Paint all pins, bolts, pinholes, and machined surfaces with a department-approved rust preventative. Securely wire all loose parts to adjacent members, or label and pack them in boxes.
- (9) Remove timber structures or parts of timber structures designated for salvage in a manner that prevents damage to the members.
- (10) If the engineer approves, and if the contract specifically authorizes using matchmarked material, the contractor may temporarily use materials designated for salvage to construct new work. Do not damage or reduce the value of those materials through temporary use.

203.3.3 Closing Culverts

- (1) The contractor may close culverts instead of removing them if the following conditions exist:
 - 1. The diameter or span of a culvert is less than 4 feet (1.2 m).
 - 2. The top of the culvert does not come within 5 feet (1.5 m) of the elevation of the finished roadway.
 - 3. The engineer deems the structure to be in suitable condition.
- (2) Remove the headwalls and those parts of the structure that would be within 2 feet (0.6 m) of the finished ground line. Completely fill each end of the culvert with satisfactory soil for a distance from each end of at least 2 feet (0.6 m) plus the height of the opening of the structure.

203.3.4 Incorporating or Disposing of Materials

- (1) Remove materials resulting from culvert or bridge removals that are not designated for salvage or incorporation in the work, from the right-of-way. Ensure that disposal sites are neatly constructed.
- (2) Place materials designated for salvage in neat piles outside the roadway but within the right-of-way at locations the engineer designates. Clean salvaged pipe culverts. Locate the piles far enough from the traveled way so they do not create a hazard to traffic.
- (3) Incorporate broken steel-free concrete, stone, brick, and like granular material in the contract work to the extent that it is practical. The contractor may use these materials, if suitable, to construct riprap, tree wells, and similar structures. Unless the contract or the engineer specifies otherwise, incorporate the balance of these materials, if they have suitable engineering properties, in embankments as specified for placing rocks under [207.3.4](#). Do not place these materials within 8 inches (200 mm) of the surface of the earth grade.
- (4) Incorporate excavated material in the work to the extent that it is practical. Use materials with suitable engineering properties to backfill areas resulting from removals and to construct embankments. Dispose of surplus or unsuitable material as specified under [205.3.12](#).
- (5) If placing broken concrete, stone, brick, or any other waste material outside the right-of-way, conform to all regulations governing solid waste disposal. Obtain written permits for this disposal from the owner of the property where placing the material, unless disposing of the material at a licensed waste disposal operation. Furnish permits, or copies of permits, to the engineer before disposal begins. Do not deposit waste in wetlands.
- (6) Arrange with the owners for the disposal of private entrance pipes that are removed but not replaced.
- (7) Unless the contract or the engineer gives more specific instructions, neatly store structural steel designated for salvage on blocking in a location suitable for loading. Store structures or portions of structures, specified in the proposal for re-erection, in separate piles.
- (8) Remove all nails and bolts from timber or piling from old structures, designated for salvage. Store this timber or piling in neat piles in locations suitable for loading. Dispose of waste timber and lumber by open burning, if allowed; by burning in an air curtain destructor, if allowed; by chipping, or dispose of as specified for surplus material in [205.3.12](#). Dispose of chipped material as specified for machine cutting or chipping in [201.3\(13\)](#). Dispose of creosote treated piling as required by the WDNR.

203.3.5 Backfilling

- (1) Backfill all trenches resulting from removing or breaking down old culverts and bridges, and not occupied by new structures or required for waterways. Use either satisfactory soil or broken masonry and satisfactory soil. If the contract specifies granular backfill, use backfill material conforming to [section 209](#). Place backfill material in layers no thicker than 8 inches (200 mm). If using granular backfill, the contractor may place granular backfill in layers up to 12 inches (300 mm) thick. Thoroughly compact each layer using engineer-approved tampers, rollers, or vibrators. If encountering water in an excavation, place backfill in a manner that displaces the water and does not trap it.
- (2) Do not use water to expedite settlement of backfill except with the engineer's approval. However, this provision does not require the contractor to de-water the excavation before placing backfill.

203.4 Measurement

- (1) The department will measure Removing Small Pipe Culverts as each individual small culvert removal acceptably completed.
- (2) The department will measure the Removing Old Structure bid items as a single lump sum unit for each culvert or bridge removal designated in the proposal and acceptably completed.
- (3) The department will not deduct the volume of these removals from the volume of the associated roadway, drainage, or structure excavation item.

203.5 Payment

203.5.1 General

- (1) The department will pay for the measured quantity at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
203.0100	Removing Small Pipe Culverts	EACH
203.0200	Removing Old Structure (station)	LS

- (2) Payment is full compensation for breaking down, removing, required salvaging, storing, and disposing of all materials; and, unless the contract specifies granular backfill, for backfilling.
- (3) Removing all non-rectangular culverts with a cross sectional area smaller than the area of a 12-inch (305 mm) diameter round pipe is incidental to associated items of work.
- (4) The department will pay for backfilling separately under [209.5](#) if the contract specifies granular backfill.

203.5.2 Removing Small Pipe Culverts

- (1) Under the Removing Small Pipe Culverts bid item, remove non-rectangular culverts with a cross sectional area equivalent to or larger than the area of a 12-inch (305 mm) diameter round pipe but smaller than a 60-inch (1.52 m) diameter round pipe.
- (2) The department will pay for each individual pipe in a multi-pipe cluster at the contract price each. All associated precast components are incidental to this bid item. The department will pay for all associated cast-in-place components separately under the appropriate removal item in section 204.
- (3) If required in [104.7](#) or if the engineer directs removing a culvert, conforming to the classification criteria for this bid item but not shown on the plan, the department will pay for that removal at the contract price each. If a removal that the plans show as a small pipe culvert conforms to the classification criteria for the Removing Old Structure bid items, the department will pay for that removal as extra work.

203.5.3 Removing Old Structure

- (1) Under the Removing Old Structure bid items, remove bridge-like structures. The department classifies a removal as a bridge-like structure if the structure is one or more of the following:
 1. A bridge with a span of 20 feet (6.1 m) or greater.
 2. Bridge-like with a span less than 20 feet (6.1 m).
 3. A rectangular culvert of any size.
 4. A non-rectangular culvert with a cross sectional area equivalent to or larger than the area of a 60-inch (1.52 m) diameter round pipe.
- (2) Payment includes removing all associated incidental structures, hybrid concrete box culverts with associated pipe culvert extensions, and multi-cell and multi-pipe systems. If required in [104.7](#) or if the

engineer directs removing a structure, conforming to the classification criteria for this bid item but not included in the proposal, the department will pay for that removal as extra work.

- (3) The contractor will bear all expenses, including engineering costs, for restoring structurally damaged girders as specified in [203.3.2\(3\)](#).

SECTION 204 REMOVING OR ABANDONING MISCELLANEOUS STRUCTURES

204.1 Description

- (1) This section describes wholly or partially removing or abandoning existing miscellaneous structures, disposing of the resulting materials, or if required, salvaging and storing designated materials.

204.2 (Vacant)

204.3 Construction

204.3.1 General

204.3.1.1 General Requirements

- (1) If retaining a portion of the existing structure, avoid damaging that portion during construction operations. Do not use any equipment or devices that might damage structures, facilities, or property to be preserved and retained. Complete all operations necessary to remove or abandon an existing structure and that might endanger the new construction before constructing new work.

204.3.1.2 Backfilling

- (1) Backfill all trenches, holes, and pits resulting from breaking down, removing, or abandoning miscellaneous structures as specified for backfilling trenches in [203.3.5](#).
- (2) Unless the contract specifies otherwise, backfill to the elevation of the natural ground, the proposed finished earth subgrade, or finished slopes, as necessary due to the location of the removed structure.

204.3.1.3 Salvaging or Disposing of Materials

- (1) Carefully remove all materials designated for salvage to avoid damage. Place salvaged materials in neat piles outside construction limits but within the right-of-way, at locations the engineer approves. Stockpile ballast, gravel, and surfacing materials designated for salvage at locations the engineer approves, without contaminating the material with dirt or foreign matter.
- (2) Dispose of all concrete, stone, brick, and other material not designated for salvage as specified for disposing of materials under [203.3.4](#).

204.3.2 Breaking Down and Removing

204.3.2.1 General

- (1) Unless specified otherwise, remove all structures that the contract designates for removal or that interfere with the new construction as follows:
 - From within the roadway.
 - From within the removal limits the plans show.
 - From within the limits designated under the Obliterating Old Road bid item, whether specified or subsequently found necessary and required.
 - If the contract specifies, also wholly or partially remove structural elements occurring outside the limits of construction and beyond the limits of Obliterating Old Road.
- (2) Unless the plans show otherwise, remove entirely or break down all walls, piers, surface drains, foundations, and similar masonry structures as follows:
 1. Within the roadbed, to a depth at least 2 feet (0.6 m) below the subgrade.
 2. Outside the roadbed, to a depth at least 2 feet (0.6 m) below the finished grade.
 3. At any location, to the extent required to avoid interfering with the work.
- (3) If removing pavement, curb, gutter, sidewalk, crosswalk, and similar structures and portions of the existing structure are to remain in the surface of the finished work, remove the structure to an existing joint, or saw and chip the structure to a true line with a face perpendicular to the surface of the existing structure. Remove enough of the structure to provide proper grades and connection to the new work. Maintain drainage as specified for drainage during construction in [205.3.3](#).
- (4) The contractor becomes the owner of the removed asphaltic pavement or surfacing and is responsible for its disposal as specified for disposing of materials under 204.3.1.3.

204.3.2.2 Removing Items

- (1) Under the Removing Pavement bid item, remove concrete pavements, concrete alleys, concrete driveways, or rigid base including all surfaces or other pavements superimposed on them, except that asphaltic pavement salvaged under section 490 bid items are not included in Removing Pavement.
- (2) Under the Removing Pavement Butt Joints bid item, remove concrete pavements to allow the construction of butt joints. Remove existing pavement to the depth the plans show by grinding, planing, chipping, sawing, or other engineer-approved methods.
- (3) Under the Removing Asphaltic Surface bid item, remove all types of asphaltic pavement or surfacing not supported on rigid bases, or underlain by proposed excavation, or overlaid by proposed embankment. Also, remove asphaltic overlays of existing concrete pavements, bases, or bridge decks designated to remain in place.
- (4) Under the Removing Asphaltic Surface Butt Joints bid item, remove asphaltic pavement or surfacing to allow the construction of butt joints. Remove existing asphaltic pavements or surfacing to the depth the plans show by grinding, planing, chipping, sawing, or other engineer-approved methods.
- (5) Under the Removing Asphaltic Surface Milling bid item, remove and dispose of existing asphaltic pavement or surfacing by milling at the location and to the depth the plans show. Mill the asphaltic pavement or surfacing as specified for milling salvaged asphaltic pavement in [490.3.2](#).
- (6) Under the Removing Concrete Sidewalk bid item, remove concrete sidewalk, crosswalk, and steps.
- (7) Under the Removing Lip Curb bid item, remove lip curb to the plane of the pavement surface, +/- one inch (25 mm).
- (8) Under the Removing Concrete Slope Paving bid item, restore the slope in front of the abutment to a smooth, plane surface after removing the slope paving.
- (9) Under the Removing Marker Posts bid item, remove and stockpile marker posts for others to salvage. Avoid damaging marker posts during removal and store the removed posts in neat piles on the right-of-way for others to salvage. Fill and tamp the resulting hole immediately after removal.
- (10) Under the Removing Railroad Track bid item, remove all rails, paving, ties, track encasement, and other appurtenances. Remove concrete foundation, and leave in place crushed stone or gravel ballast, unless specified otherwise.
- (11) Under the Removing Manholes, Removing Catch Basins, and Removing Inlets bid items, rebuild, and properly reconnect all live sewers connected with them. Maintain satisfactory bypass service during these operations. Plug unused sewers as specified for abandoning pipes and structures under [204.3.3.1](#).
- (12) Under the Removing Septic Tanks bid item, first completely remove the contents of the tank. Conform to the WDNR requirements for removal and disposal of these contents. Break down and remove the tank, to an elevation not less than 2 feet (0.6 m) below the proposed ground surface, or 2 feet (0.6 m) below the finished slopes or natural ground surface, as required due to the location of the tank. Before backfilling, break a hole in the bottom of any remaining portion of the tank to allow drainage. Backfill as specified for trenches, holes, and pits in [204.3.1.2](#). If the septic tank disposal system includes a dry well, remove the dry well to not less than 2 feet (0.6 m) below ground surface, and backfill it in the manner specified above for the septic tank.
- (13) Under the Site Clearance bid items, remove building foundations and concrete slabs, backfill exposed openings, and clear the site within the right-of-way at the locations the plans show. Materials removed from building sites under this bid item become the contractor's property. The contractor may incorporate these materials in the roadway embankment if the engineer approves. Clear the entire premises of all decomposable and combustible refuse, debris, and materials resulting from the removals and leave the premises in a neat condition.
- (14) Under the Removing Storm Sewer bid items, remove existing storm sewer. Backfill all resulting trenches with granular backfill conforming to [section 209](#).

204.3.2.3 Removing Buildings

- (1) Under the Removing Building and Removing Buildings bid items, remove buildings, dispose of all material and debris resulting from removing buildings, and backfill all resulting holes.

- (2) All buildings removed and all materials resulting from building removal become the contractor's property unless the contract specifies otherwise. Dispose of unclaimed and removed material as specified for disposing of materials in [203.3.4](#).
- (3) The department assumes no responsibility for the condition of any building at any time. The department makes or implies no guarantee that any building will remain in the condition the bidder finds it in when the bidder prepares its proposal.
- (4) Procure all permits necessary for removing buildings, including those necessary if the contractor's operations obstruct streets or alleys.
- (5) Remove buildings and building materials safely and according to the requirements of the Wisconsin department of workforce development, applicable ordinances of the municipality where the building is located, and the WDNR. Pay close attention to the requirements regulating the handling and disposal of asbestos, lead paint, and other hazardous substances. If creating hazardous conditions incident to the contract operations, furnish, erect, and maintain suitable barricades to safeguard the public.
- (6) Notify public utility companies serving the building in sufficient time, before removal operations, to allow them to disconnect and remove their facilities from the building.
- (7) Shut off municipal water service lines at the curb boxes. Tightly plug or seal sewer connections. If municipal ordinances or permits specify the manner of sealing a sewer service connection, then perform the work accordingly.
- (8) Unless the contract specifies otherwise, when removing a building also remove that portion of its foundation, including any masonry floors, to an elevation not less than 2 feet (0.6 m) below the ground surface, the proposed finished earth subgrade, or finished slope grade, as necessary due to the location of the building.
- (9) Remove heating units, plumbing fixtures, and similar appurtenances to the elevation of the basement floor.
- (10) Before backfilling, remove all debris not suitable for backfilling. Break holes comprising at least 10 percent of the floor area in basement floors to allow drainage.

204.3.3 Abandoning Pipes and Structures

204.3.3.1 General

- (1) If the contract calls for abandoning manholes, catch basins, or inlets, clean them thoroughly. Plug the existing pipe connections with brick or concrete block masonry, or with any grade of concrete specified under [501.3.1.3](#), or any engineer-approved commercial grade of concrete. Unless the plans show otherwise, remove the walls of the structures as follows:
 - 1. Within the roadbed, to a depth at least 2 feet (0.6 m) below the subgrade.
 - 2. Outside the roadbed, to a depth at least 2 feet (0.6 m) below the finished grade.
 - 3. At any location, to the extent required to avoid interfering with the work.

204.3.3.2 Abandoning, Closing, and Sealing Items

- (1) Under the Abandoning Culvert Pipes bid item, plug both ends of the abandoned pipe as specified in 204.3.3.1.
- (2) Under the Closing Culvert Pipes bid item, close both ends of the abandoned pipe as specified for closing culverts in [203.3.3](#).
- (3) Under the Sealing Pipes bid item, thoroughly clean the ends of the abandoned pipe, and seal them with brick, concrete block, or any grade of concrete specified under [501.3.1.3](#).

204.3.3.3 Abandoning Wells

- (1) Under the Abandon Wells bid item, fill and seal wells used to previously supply water. Comply with NR 812 of the Wisconsin administrative code. Seal an abandoned well before performing excavation or other contract work that might cause the location of the well to be lost. Before abandoning the well, remove all drop pipes, obstructions, or debris that might interfere with or prevent sealing or filling the well.
- (2) For drilled wells, cut off the casing at an elevation not less than 2 feet (0.6 m) below the natural ground surface, proposed earth subgrade, or finished grade of slopes, as necessary due to the location of the well. Remove all concrete at the well site above the cutoff elevation of the casing. Dispose of the masonry

as specified for disposing of materials in [204.3.1.3](#). Fill the casing to the cutoff elevation with concrete or bentonite chips. Place the concrete through a conductor pipe, except if practical use a dump bailer. If placing concrete under water with a conductor pipe, submerge the bottom end of the conductor pipe in the concrete at all times. Backfill excavations at the well site with suitable soils or, if specified, granular backfill to the finished earth grade or natural ground surface as specified for backfilling trenches in [203.3.5](#).

- (3) For dug wells, remove all masonry or lining to an elevation not less than 7 feet (2.1 m) below the natural ground surface, proposed earth subgrade, or finished grade of slopes, as necessary due to the location of the well. Fill the well with concrete, bentonite chips, or soil consisting of clay or other impervious clayey soils. Substantially remove all water in the well. Place the soil in layers, and firmly compact it in a manner to seal the well thoroughly and to minimize settlement. If the well is located within the limits of the proposed roadbed or other proposed load bearing areas, place the soils, at or near optimum moisture content, in layers not greater than 8 inches (200 mm). Firmly compact the soils to preclude settlement. The contractor may fill dug wells with concrete or bentonite chips to an elevation 2 feet (0.6 m) below the finished earth grade or natural ground surface. Place suitable soils or, if specified, granular backfill above the concrete or bentonite chips.
- (4) The contractor may use bentonite chips to fill drilled or dug wells within the following limitations.
 1. The well is in bedrock, sand, or gravel.
 2. The well is 4 inches (100 mm) or larger in diameter.
 3. The well is no more than 250 feet (75 m) deep.
 4. There is no more than 150 feet (45 m) of standing water in the well.
 5. If using the chips to cap a well partially filled with drilling mud or clay slurry, provide bentonite chips for at least the top 20 feet (6 m).
- (5) Obtain the department's approval of the bentonite chip material before use. Use irregularly shaped particles. The department will not accept pellets or tablet shaped particles.
- (6) Use bentonite chips in the 1/4-inch (6 mm) to 3/8-inch (10 mm) range to seal wells 4 inches (100 mm) in diameter, and in the 3/8-inch (10 mm) to 3/4-inch (20 mm) range to seal wells larger than 4 inches (100 mm) in diameter. Before using, screen the chips to remove particles smaller than the smallest standard size in the selected range. To avoid bridging in the well, do not exceed a rate of pour into the well of one 50-pound (22.7 kg) bag in 3 minutes.
- (7) Calculate the number of bags needed to fill the well using the following formula. Use of fewer bags than calculated indicates that the chips have bridged. Before the engineer will accept the seal, the contractor shall clear the point of bridging or drill out the well, and repeat until accepted.

$$N = \pi \times r^2 \times h / 0.6886$$

Where:

N = number of 50 lb bags required

r = well radius in feet

h = well depth in feet

0.6886 = volume of one 50 lb bag in cubic feet

$$N = \pi \times r^2 \times h / 0.0195$$

Where:

N = number of 22.7 kg bags required

r = well radius in meters

h = well depth in meters

0.0195 = volume of one 22.7 kg bag in cubic meters

- (8) Standing water in the well will rise to the top after filling. If it does not, pour clean water into the well through the chips until water does rise to the top.
- (9) Use any grade of concrete specified under [501.3.1.3](#) or any engineer-approved commercial grade to fill and seal wells.

- (10) Use suitable soils taken from roadway excavation to fill dug wells. If suitable soils are not available, furnish the soils from sources outside the right-of-way.

204.4 Measurement

- (1) Unless specified otherwise, the department will measure this work in the original position of the removed structures. If the contract does not include bid items for removing the listed miscellaneous structures from within the roadway, the department will measure the excavation for those removals as common excavation. The department will determine the volume of excavation for removing concrete structures as the area of the structure times the depth removed.
- (2) The department will measure Removing Pavement, Removing Pavement Butt Joints, Removing Asphaltic Surface, and Removing Asphaltic Surface Butt Joints by the square yard acceptably complete regardless of the depth or number of courses encountered. The department will measure Removing Asphaltic Surface Milling by the square yard, or by the ton acceptably completed.
- (3) If removing curb, gutter, or curb & gutter is required in conjunction with removing pavement, the department will measure removing these structures by the square yard acceptably completed, under the Removing Pavement bid item. If removing a rigid base with an asphaltic surface extending beyond the lateral limits of the rigid base, as in a widened pavement, the department will measure only the area occupied by the rigid base under the Removing Pavement bid item. The department will measure the portion of the asphaltic surfacing beyond the rigid base removed under the Excavation bid items or the Obliterating Old Road bid item. The department will make no deductions for any opening in the removed pavement having an area of 3 square yards (3 m²) or less.
- (4) The department will make no deductions from the volume measured under the Excavation bid items for pavement removed as specified under removing pavement or removing asphaltic surface in [204.3](#).
- (5) If removing curb, gutter, or curb & gutter that is separate from and not removable in conjunction with removing pavement, the department will measure Removing Curb, Removing Gutter, and Removing Curb & Gutter by the foot acceptably completed, measured along the flow line of gutter for gutter, or curb & gutter, and along face of curb for curb.
- (6) The department will measure Removing Concrete Sidewalk by the square yard acceptably completed. The department will include steps based on the area of the horizontal projection of the steps.
- (7) The department will measure Removing Lip Curb, Removing Guardrail including end sections or anchorages, and Removing Fence by the linear foot acceptably completed.
- (8) The department will measure Removing Concrete Slope Paving by the square yard acceptably completed, measured in the plane of the removal surface.
- (9) The department will measure Removing Marker Posts as each individual post acceptably completed.
- (10) The department will measure Removing Masonry by the cubic yard acceptably completed.
- (11) The department will measure Removing Surface Drains as each individual surface drain acceptably completed.
- (12) The department will measure Removing Concrete Bases as each individual concrete base acceptably completed.
- (13) The department will measure Removing Railroad Track by the linear foot acceptably completed, measured along single track lines, tracks with 2 rails.
- (14) The department will measure Removing Utility Poles as each individual pole, or pole stub acceptably completed, including all attached parts and connections.
- (15) The department will measure Removing Manholes, Removing Catch Basins, and Removing Inlets as each individual manhole, catch basin, or inlet acceptably completed, including all attached parts and connections.
- (16) The department will measure Removing Septic Tanks as each individual septic tank acceptably completed, including any dry wells in the tank's disposal system.
- (17) The department will measure the Removing Building (station) bid items as a single lump sum unit for each building acceptably completed. The department will measure the Removing Building (parcel) bid items as a single lump sum unit for all buildings within the specified parcel acceptably completed.

- (18) The department will measure the Site Clearance bid items as a single lump sum unit for each specified parcel acceptably completed.
- (19) The department will measure the Removing Storm Sewer bid items by the linear foot acceptably completed, measured along the centerline of the pipe.
- (20) The department will measure Abandoning Manholes, Abandoning Catch Basins, Abandoning Inlets, and Abandoning Wells as each individual manhole, catch basin, inlet, and well acceptably completed.
- (21) The department will measure Abandoning Culvert Pipes, Closing Culvert Pipes, and Sealing Pipes as each individual pipe acceptably completed, having both ends plugged.

204.5 Payment

204.5.1 General

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
204.0100	Removing Pavement	SY
204.0105	Removing Pavement Butt Joints	SY
204.0110	Removing Asphaltic Surface	SY
204.0115	Removing Asphaltic Surface Butt Joints	SY
204.0120	Removing Asphaltic Surface Milling	SY
204.0125	Removing Asphaltic Surface Milling	TON
204.0130	Removing Curb	LF
204.0140	Removing Gutter	LF
204.0150	Removing Curb & Gutter	LF
204.0155	Removing Concrete Sidewalk	SY
204.0160	Removing Lip Curb	LF
204.0165	Removing Guardrail	LF
204.0170	Removing Fence	LF
204.0175	Removing Concrete Slope Paving	SY
204.0180	Removing Marker Posts	EACH
204.0185	Removing Masonry	CY
204.0190	Removing Surface Drains	EACH
204.0195	Removing Concrete Bases	EACH
204.0200	Removing Railroad Track	LF
204.0205	Removing Utility Poles	EACH
204.0210	Removing Manholes	EACH
204.0215	Removing Catch Basins	EACH
204.0220	Removing Inlets	EACH
204.0225	Removing Septic Tanks	EACH
204.0230	Removing Building (station)	LS
204.0235	Removing Building (parcel)	LS
204.0240	Site Clearance (parcel)	LS
204.0245	Removing Storm Sewer (size)	LF
204.0250	Abandoning Manholes	EACH
204.0255	Abandoning Catch Basins	EACH
204.0260	Abandoning Inlets	EACH
204.0265	Abandoning Wells	EACH
204.0270	Abandoning Culvert Pipes	EACH
204.0275	Closing Culvert Pipes	EACH
204.0280	Sealing Pipes	EACH

- (2) Payment for removing or abandoning miscellaneous structures is full compensation for breaking down, removing, closing, plugging, or sealing; for removing and disposing of headwalls; for obtaining any required work permits; for hauling and disposing of materials; for providing any required bentonite, soil, brick, concrete block, or concrete; for restoring the roadway cross-section; and, unless the contract specifies granular backfill, for backfilling.

- (3) If granular backfill is required for work under section 204 bid items, the department will pay for that backfill as follows:
1. If the contract specifies granular backfill, at the unit price for the Backfill Granular bid item.
 2. If the contract does not specify granular backfill, that backfill is incidental to the work.
 3. If the contract does not specify granular backfill but granular backfill is later found necessary and required, the department will pay for that backfill as extra work.
- (4) If the contract does not include bid items for removing the listed miscellaneous structures from within the roadway, the department will pay for excavating these removals under the Excavation Common bid item. Except, the department will pay for excavation for removing concrete structures exceeding one cubic yard (1 m³), that were not specified for removal in the contract, at 5 times the unit price bid for Excavation Common under the Removing Miscellaneous Concrete Structures administrative item. Other work involved in removing or abandoning miscellaneous structures within the roadway is incidental to the work.
- (5) If the contract does not include a separate bid item for removing any of the miscellaneous structures listed above from within the limits of Obliterating Old Road, all work involved in the removal thereof, whether specified or subsequently found necessary and required, is incidental to Obliterating Old Road.
- (6) If the contract does not include a separate bid item for removing any of the miscellaneous structures listed above from beyond the roadway and outside the limits of Obliterating Old Road, all work involved in the removal, if the removal is specified in the contract, is incidental to other bid items of work. If this removal is not specified but later found necessary and required, the department will pay for all work involved in this removal as extra work.

204.5.2 Storm Sewer

- (1) If the contract or the engineer requires storm sewer removal and the contract does not include the Removing Storm Sewer bid item, the department will pay for that removal as extra work.

SECTION 205 ROADWAY AND DRAINAGE EXCAVATION

205.1 Description

- (1) This section describes excavating and disposing of material taken from within the right-of-way for project construction.
- (2) This section does not include material obtained from borrow pits outside the right-of-way limits, excavation for structures, or other excavation that separate bid items and specific measurement and payment are specified elsewhere in the specifications and contract.

205.2 Materials

205.2.1 Classification

- (1) The department classifies excavation as common, rock, stone piles and stone fences, or marsh excavation. If the contract contains the Excavation Common and Excavation Rock bid items, the engineer will classify that excavation as either common or rock, based on unfrozen material, as the contractor performs the work.
- (2) The department classifies all EBS outside of marshes as common or rock.

205.2.2 Common Excavation

- (1) Under the Excavation Common bid item, excavate all materials not classified as rock, stone piles and stone fences, or marsh excavation. For contracts without the Excavation Rock bid item, remove boulders having volumes of one cubic yard (1 m³) or more under the Excavation Common bid item.

205.2.3 Rock Excavation

- (1) Under the Excavation Rock bid item, excavate all hard, solid rock in ledges, bedded deposits, and unstratified masses, and all conglomerate deposits or any other material so firmly cemented they present all the characteristics of solid rock, and the engineer determines it is not practical to excavate this material without blasting or using rippers. Rock excavation also includes removing all rock boulders having a volume of one cubic yard (1 m³) or more.
- (2) The classification of rock excavation does not apply to crushed aggregate or asphaltic base or surface courses, or to portland cement base or surface courses.

205.2.4 Stone Piles and Stone Fences

- (1) Under the Excavation Stone Piles and Stone Fences bid item, remove and dispose of stones, boulders, and rock fragments found assembled on the right-of-way in piles so that the engineer can make collective measurements by volume of the weight. If the contract includes a bid for this bid item, the classification is applicable to all portions of the piles or assembled stone masses found on the right-of-way that are removed and disposed of as specified. This applies regardless of whether this material occurs entirely above or partially below the ground surface. Do not classify stones in groups or piles of less than one cubic yard (1 m³) in volume under stone piles and stone fences.

205.2.5 Marsh Excavation

- (1) Under the Excavation Marsh bid item, perform all required excavation below the original ground level of marshes and swamps underlying proposed embankments, within the limits indicated on the plans or as determined by the engineer, and necessary or desirable to ensure a stable foundation for embankment or to accelerate the subsidence of unstable material under embankment load. If old road embankment cores are encountered in areas involving marsh excavation, salvage the portions of old road cores as designated on the plans and use them in the construction of embankments. This bid item also includes all material of whatever nature encountered below the original ground elevations in areas designated for this work, exclusive of portions of old road cores designated for salvage and used in construction of embankments.
- (2) On contracts containing the Excavation Marsh bid item, excavate any marsh areas not indicated on the plans but encountered during construction as marsh excavation if the engineer orders removing these areas.

205.3 Construction

205.3.1 General

- (1) Excavate materials as the plans show or the engineer allows from within the right-of-way. Use excavated material in the work to the extent that it is practical. Use excavated material with suitable engineering properties to construct the roadway, roadbed, embankments, earth subgrade and shoulders, intersections, side ditches and dikes, channels, and waterways. Dispose of surplus or unsuitable material as specified in [205.3.12](#).
- (2) Grade entrances, approaches, ditches, and channels beyond the right-of-way.
- (3) Unless specified otherwise, remove and dispose of surface and base, embankment surcharge, masonry walls, foundations of buildings, or other miscellaneous structures that lie within the right-of-way. Also, remove and dispose of stone fences, stone piles, and surplus and unsuitable materials.
- (4) Replace unsuitable material with satisfactory material. Trim and finish the roadway. Maintain the work done under section 205 in a finished condition until acceptance.

205.3.2 Preparing Roadway Foundation

- (1) Remove vegetation taller than one foot (300 mm) before excavating or placing embankment. Remove heavy sod, perishable material, unstable topsoil, muck, peat, and other undesirable material from the roadway foundation as defined in [101.3](#). Dispose of removed material as specified in [205.3.12](#) unless the contract or the engineer directs otherwise.
- (2) Salvage topsoil, as specified in [625.3.2](#), from excavation areas and the roadway foundation. Remove excess unstable topsoil from the roadway foundation as EBS as specified in 205.3.4.
- (3) Compact, or prepare otherwise as required, the existing ground within the roadway foundation as necessary to support the embankment and attain the specified embankment density.
- (4) If placing embankment on side slopes 10 feet (3 m) high or higher and steeper than one vertical to 3 horizontal, provide vertically faced horizontal steps or benches in the slopes to support the embankment. The contractor may cut or form the steps or benches while placing the embankment.
- (5) Completely remove all pavement, asphaltic surface, and rigid base from within the roadbed slopes and underlying proposed embankments to a depth of 2 feet (0.6 m) or more below the finished grade line, or to the depth the plans show.

205.3.3 Drainage During Construction

- (1) During construction, maintain roadway, ditches, and channels in a well-drained condition at all times by keeping the excavation areas and embankments sloped to the approximate section of the ultimate earth grade. Perform blading or leveling operations when placing embankments and during the process of excavation except if the excavation is in ledge rock or areas where leveling is not practical or necessary. If it is necessary in the prosecution of the work to interrupt existing surface drainage, sewers, or under drainage, provide temporary drainage until completing permanent drainage work.
- (1) If storing salvaged topsoil on the right-of-way during construction operations, stockpile it to preclude interference with or obstruction of surface drainage.
- (2) Seal subgrade surfaces as specified for subgrade intermediate consolidation and trimming in [207.3.9](#).
- (3) Preserve, protect and maintain all existing tile drains, sewers, and other subsurface drains, or parts thereof, that the engineer judges should continue in service without change. Repair, at no expense to the department, all damage to these facilities resulting from negligence or carelessness of the contractor's operations.

205.3.4 Excavation Below Subgrade

- (1) Remove deposits of frost-heave material, unstable silty soils, wet and unstable soil, material salvaged from old road cores in marshes, topsoil containing considerable amounts of humus or vegetable matter, rocks, or other undesirable foundation material to the depth below finished grade as the plans show or the engineer directs. If possible, slope and drain the excavation bottoms to prevent water accumulation.
- (2) Dispose of humus bearing soils and other excavated materials not suitable for embankment construction as specified for disposal of surplus or unsuitable material in [205.3.12](#).

- (3) Use selected materials from roadway and drainage excavation having suitable engineering properties, borrow, or granular backfill, as the plans or special provisions show or as the engineer directs, to backfill excavated areas.

205.3.5 Grading the Roadway, Intersections, and Entrances

- (1) Use all material with suitable engineering properties removed from excavation, to the extent that it is practical, to construct the roadway. Use excess excavated material in other locations the plans show.
- (2) Undercut or under fill to the necessary depth, all excavated slopes or areas and all embankment slopes or areas designated to receive topsoil or salvaged topsoil in order to provide for placement and finish of the specified amount of topsoil or salvaged topsoil to the required grade lines and section.
- (3) Perform excavation to avoid removing or loosening any material outside the required slopes. Replace and thoroughly compact any material removed or loosened to the required cross-section.
- (4) Grade all intersecting roads, approaches, entrances, and driveways as the plans show or as laid out by the engineer. Construct intersections and private entrances, trim shoulders and slopes, finish and blade the earth subgrade, and complete the ditches to the proper alignment, grade, and cross-section closely following the rough grading.

205.3.6 Constructing Ditches, Dikes, and Channels

- (1) Construct inlets, outlets, swamp, berm and intercepting ditches, dikes, or intercepting embankments and channels where and as the plans show or where and as directed by the engineer. Maintain inlets, outlets, swamp, berm and intercepting ditches, dikes, or intercepting embankments and channels to the required section until acceptance. Perform the work in proper sequence with other work to provide adequate drainage and to minimize erosion and siltation.
- (2) The department will include excavation from ditches and channels with the pertinent bid items classified under roadway and drainage excavation.
- (3) Use all material with suitable engineering properties excavated from ditches and channels, to the extent that it is practical, to construct the roadway and backfill abandoned ditches and channels. Dispose of unused excavated material as the plans show or as the engineer directs.
- (4) Do not deposit waste or surplus excavation within 3 feet (1 m) of the edge of ditches or channels or within a greater distance as required to ensure stability of the side slopes. Spread waste or surplus material in thin, neatly shaped, uniform layers. Remove roots, stumps, logs, and other objectionable material in the slopes and bottoms of ditches and channels. Backfill the holes with suitable material, or cut the holes to conform to the cross-section the plans show. If necessary, provide sufficient openings in spoil banks to allow surface drainage of adjacent lands.
- (5) Provide suitable outlets or flumes from intercepting ditches to roadway ditches where necessary as the plans show.

205.3.7 Excavating Rock

205.3.7.1 General

- (1) Remove rock, if encountered in excavation, to a depth of approximately 6 inches (150 mm) below the earth subgrade between limits of the shoulder slopes. If the plans show design details covering the depth of rock excavation, perform the work according to the details. If the plans or special provisions do not require specific materials, then use selected material obtained from roadway and drainage excavation to backfill areas of EBS in rock excavation. If excavation methods leave undrained pockets in the rock surface, drain the depressions properly. If allowed by the engineer the contractor may fill the depressions with engineer-approved impermeable material, at no expense to the department.
- (2) Excavate rock cuts using methods and equipment so that the resulting backslopes substantially conform to the slopes the plans show or to the slopes established from the stakes set for excavation. Avoid creating depressions in or substantial displacement of material outside the lines, limits, or slope planes defined by the stakes. Scale the backslopes in rock cuts to dislodge loose rock. Dispose of removed material in the manner specified for other excavation.
- (3) Undercut the slopes of rock cuts if designated to receive topsoil, or salvaged topsoil to the depth necessary to allow placing the specified amount of topsoil or salvaged topsoil, and finish to the required section.

205.3.7.2 Presplitting Rock

- (1) If the plans show or the engineer authorizes, employ the presplitting technique to split the face of the rock cut in a relatively smooth plane along the designated backslope, before removing the interior portion of the cut by blasting.
- (2) Remove all soil, loose, or decomposed rock overlying the surface of the rock to be split to the elevation the engineer designates or approves before drilling the presplitting holes.
- (3) At the beginning of the presplitting operation or if encountering material of different geologic characteristics, drill, blast, and excavate short test sections, up to 100 feet (30 m) in length, to determine the optimum spacing, size, and loading of the holes. Do not perform testing until the engineer approves a contractor-prepared plan of the test section. After presplitting the test section, expose the presplit face to allow the engineer to examine and evaluate the results. If the results are unsatisfactory, make adjustments in hole size and spacing, size and spacing of charges, and other aspects of the plan to produce an acceptable split face.
- (4) Drill holes not larger than 3 1/2 inches (90 mm) in diameter at a spacing determined from the test section, but not less than 24 inches (600 mm) and not more than 42 inches (1100 mm).
- (5) Drill holes on the required slope line and at the required slope inclination to the full depth of the cut or to a predetermined stage elevation. If the depth of cut is greater than is practical to maintain the required alignment of the drilled holes, drill, blast, and excavate the cut in 2 or more lifts. If the cut is too deep for presplitting to the full-required depth in one operation, the engineer will allow a maximum offset of 12 inches (300 mm) at the bottom of each lift for use in drilling the next lower presplitting pattern. Plan the offset benches so the toe of the completed rock slope coincides with the toe of slope the plans show.
- (6) Carefully charge all drill holes for presplitting with manufactured cartridge-type explosives, fully stem each hole, and detonate the charges simultaneously.
- (7) Before blasting the interior portion of the excavation area, presplit rock slopes, either by separate operations or by time delay fuses that fracture the slope line before the charges detonate in the interior portion.
- (8) Position drill holes for production blasting to avoid damage to the presplit face. Do not place the bottom of the production holes below the bottom of the presplit holes. Do not drill portions of production drill holes within 4 feet (1.2 m) of a presplit plane except as the engineer approves.
- (9) Use explosive charges, detonating cord, spacing, and other items necessary for the blasting operation conforming to the explosive manufacturer's recommendations and instructions.

205.3.8 Marsh Excavation and Disposal

- (1) If encountering muck or peat marshes, complete excavation of the marshes as soon as it is practical to obtain maximum settlement before proposed base and surface construction.
- (2) Begin excavation of wet marshes with relatively unstable side slopes at one end and proceed in one direction to the full width across the entire marsh immediately ahead of backfilling. Ensure the method and sequence of excavating and backfilling result in the complete removal or displacement of all peat or muck from within lateral limits the plans show or as the engineer staked, and to the bottom of the marsh or to firm support. Excavate all displaced peat or muck accumulating ahead of the advancing embankment toe. Construct embankments as specified for placing in marsh in [207.3.3](#).
- (3) Completely excavate, to the extent that it is practical, dry marshes having relatively stable side slopes and firm bottoms to the width the plans show or as the engineer staked, and to the bottom of the marsh. Backfill the area in layers as specified for placing layers in [207.3.2](#).
- (4) Unless the contract specifies otherwise, the contractor may temporarily deposit the excavated material outside the toe of the slope of the proposed embankment but not over marsh or wetlands. After completing the embankment, place the excavated material against the fill slopes, and spread the material between the fill and marsh ditch if not placing over marsh or wetlands. Dispose of left over material as unsuitable material, or use it as the plans show. If disposing of excavated material by hauling to other locations, complete hauling before construction of any subbase, base, or surface course.

205.3.9 Removing Embankment Surcharge

- (1) Remove and dispose of excess fill placed above the elevation for earth grade over deposits of unstable material to secure displacement or settlement. Remove surcharge only after the fill has reached stability or the required settlement, as determined by the engineer.

205.3.10 Removing Masonry Walls, Foundations of Buildings, or Other Structures

- (1) Unless the plans show otherwise, remove masonry walls or foundations of buildings or other structures as follows:
 1. Within the roadbed, to a depth at least 2 feet (0.6 m) below the subgrade.
 2. Outside the roadbed, to a depth at least 2 feet (0.6 m) below the finished grade.
 3. At any location, to the extent required to avoid interfering with the work.
- (2) Break holes in basement floors to allow drainage. Backfill those portions of all basements or other openings resulting from removing buildings or other structures, or openings resulting from removing walls or foundations of buildings or structures, lying within the shoulder lines of the new roadway, subgrade elevation with suitable material from roadway excavation, unless the contract specifies granular backfill. Backfill similar openings lying outside the ditch lines of the new roadway with material secured from roadway excavation.

205.3.11 Incorporating or Disposing of Stones, Broken Rock, and Boulders

- (1) Incorporate all stones, broken rock, and boulders not required for other construction included in the contract, to the extent that it is practical, in embankments outside the limits of any proposed structure or structure piling. Completely fill the voids between them with satisfactory soil. Dispose of material not incorporated in the work at no expense to the department, either by burying in the ground within the right-of-way in an engineer-approved manner or by placing off the right-of-way and out of sight from a public highway. If placing material outside the right-of-way, comply with all regulations relating to disposal of solid waste. Obtain written permits for disposal from the owner of the property where placing the material, unless disposing of the material at a licensed waste disposal operation. Furnish permits, or copies of permits, to the engineer before disposal. Do not deposit waste in wetlands.

205.3.12 Incorporating or Disposing of Surplus or Unsuitable Material

- (1) Dispose of all vegetation as specified for clearing and grubbing under [201.3](#). Save material containing humus or of a nature suitable to support vegetation but unsatisfactory for constructing embankments. Use this material in salvaged topsoil operations. The contractor may, if the engineer approves, use surplus humus-bearing soils, and other excavated materials not suitable for embankment construction but suitable to uniformly widen embankments, to flatten slopes, and to fill low places in the right-of-way for these purposes, unless specified otherwise.
- (2) Do not deposit excavated material along the roadsides above the elevation of the adjacent roadbed, unless the plans show or the engineer allows.
- (3) Dispose of surplus excavation that is not, or cannot be, disposed of by flattening slopes or filling in low places on the right-of-way, at no expense to the department. Locate disposal sites outside the right-of-way, and comply with all regulations relating to disposal of solid waste. Ensure that disposal sites are neatly constructed. In performing these operations, do not create a nuisance or cause pollution or siltation of natural watercourses, streams, lakes, wetlands, or reservoirs. Furnish written permits to the engineer as required from the owner of the property under 205.3.11 before disposal. Do not deposit waste in wetlands.

205.3.13 Finish Grading

- (1) Complete the grading, trimming, and finishing before constructing the subbase, base, or surface courses.
- (2) Make gradual adjustment in slopes to avoid injury to standing trees or to harmonize with existing landscape features, especially at the intersection of cuts and fills.
- (3) Round the crests of earth cut banks as the plans show or as the engineer directs.
- (4) Merge all constructed earth slopes with adjacent terrain and substantially conform to the plan cross-sections. Use blading or other operations, to partially smooth the horizontal serrated condition of slopes ordinarily left by excavating equipment. Produce slopes that are slightly rough and irregular and have a general contour of the required slope.

- (5) Flatten, round, or modify the slopes and banks of existing ditches, channels, berms, and dikes within the clear zone to the extent necessary to remove obstacles or obstructions encountered by vehicles leaving the adjacent traveled way.
- (6) During grading operations and pending acceptance of grading or placement of subbase, base, or surface course, provide continuous maintenance of the entire roadbed and perform all blading and repair work necessary to keep the grade smooth and to the required grade and cross-section specified. The contractor is not required to maintain or restore the minimum required density in the graded roadway after completing shaping, trimming, and finishing operations, except as specified for preparing the foundation in [section 211](#) before placing subbase or base under the contract.
- (7) Refill and compact washouts caused by erosion.

205.3.14 Preserving Trees and Shrubs

- (1) Protect trees and shrubs designated for preservation from scarring or other injury during grading operations.
- (2) If excavating around trees to be preserved, do not disturb the original ground around the trees within a minimum distance of one foot (300 mm) or twice the diameter of the tree, whichever is the greater distance. Cleanly cut exposed roots resulting from excavation, and cover them with humus-bearing soil.
- (3) If the plans, special provisions, or the engineer requires, construct tree wells to protect trees or shrubs surrounded by excavation or embankment.

205.3.15 Dust Control

- (1) Minimize dust dispersion from the subgrade during grading and maintenance operations, until the work is accepted, by applying water or other engineer-approved dust control materials as the contract specifies or the engineer requires.

205.3.16 Overhaul

- (1) All the bid items under part 2 include hauling. The department will make no allowance under the Overhaul bid item, except if during construction the quantity of roadway and drainage excavation within balance points or divisions is insufficient to make the required embankment, and no borrow excavation is specified to make up this deficiency, the engineer may require that the contractor secure additional excavation outside the balance division but within the limits of the right-of-way.

205.4 Measurement

205.4.1 Excavation

- (1) The department will measure all classes of roadway and drainage excavation by the cubic yard acceptably completed as computed using the method of average end areas, with no correction for curvature, except as follows:
 - 1. The engineer and contractor mutually agree to an alternate volume calculation method.
 - 2. The method of average end areas is not feasible.
 - 3. Other methods are specified here in 205.4.1.
- (2) For minor quantities, the engineer may elect to measure Excavation Common by the cubic yard in the vehicle. The engineer will determine the capacity of each haul vehicle to the nearest 0.1 cubic yard (0.1 m³).
- (3) The department will measure Excavation Rock in ledges and solid masses by the cubic yard acceptably completed. The department will perform this measurement by making vertical measurements for determining end areas within the limits of the roadbed as defined by the shoulder slopes. These vertical measurements will extend from the surface of the rock to an elevation 6 inches (150 mm) below the subgrade or ground surface, or to the depth indicated on the plans, or to the bottom of the solid ledge or mass if the rock does not extend downward to the elevation specified, or indicated below the established grade.
- (4) The department will measure boulders and surface stone with a volume of one cubic yard (1 m³) or more individually and compute the volume from average dimensions taken in 3 directions, except as specified below for Excavation Stone Piles and Stone Fences.

- (5) If the contract includes a separate bid item for Excavation Stone Piles and Stone Fences, the department will measure the stone piles or portions of stone piles removed in cubic yards in their original position, computed by the method of average end areas, with no correction for curvature, or, if the engineer elects, by the method of truncated prisms. Measurement under Excavation Stone Piles and Stone Fences includes all stones, regardless of size; located in the stone piles and stone fences, and the department will make no classification of stone size for material measured under this bid item.
- (6) If undercutting designated slopes to provide for placing topsoil or salvaged topsoil, the undercut is incidental to the Topsoil or Salvaged Topsoil bid items.
- (7) The department will measure Excavation Marsh in its original position, by the average end area method, within the limits of excavation. This department will use this method if the contractor excavated and formed a reasonably well-defined trench of required cross-section, with relatively stable side slopes, and a bottom that is the bottom of the marsh or a satisfactory support for the backfill and embankment. In cases that the excavation does not result in a reasonably well-defined measurable trench with relatively stable side slopes, the department will measure the cross-section area based on the lateral limits of the excavation shown by the typical section in the plans and as the engineer staked in the field. The department will determine the depth between the original marsh surface and the bottom of the placed fill by taking soundings during the marsh excavation or by taking borings through the completed fill. The department will not measure any marsh material from outside the lateral limits defined above that may be excavated or may be displaced by the fill.
- (8) If it is not possible to compute volumes of the various classes of roadway and drainage excavation by the method of average end areas due to erratic location of isolated deposits, the department may compute the volumes by alternate methods involving 3-dimensional measurements.
- (9) The department will not measure for payment materials excavated in forming benches or steps in preparing the foundation for embankments placed on slopes.
- (10) The department will not measure excavated material used for purposes the contract does not designate, except as specified for use of materials found on the project in [104.8](#). The department will not measure material excavated beyond the limits of the required slopes unless the engineer allows overbreak in rock cuts and that overbreak was beyond the contractor's control. In this case the department may measure this overbreak.
- (11) The department will measure erosion control, fertilizing, and seeding for material disposal sites as specified for material disposal sites in [628.4.12](#).

205.4.2 Overhaul

- (1) The department will determine the limits of free haul for roadway and drainage excavation from a mass diagram. Prepare this diagram by fixing on the volume curve 2 points, one on each side of the neutral grade point, one in excavation and the other in embankment, so that the distance between them equals 2000 feet (600 m) and the included quantities of excavation and embankment balance. The department will eliminate all materials within this free haul limit from further consideration. The distance between the center of gravity of the remaining mass of excavation and the center of gravity of the remaining embankment, less the limit of free haul as above described, equals the overhaul distance for roadway and drainage excavation.
- (2) The department will calculate the quantity of Overhaul as the product of the overhaul distance, in miles, multiplied by the quantity of overhaul material in cubic yards.
- (3) The engineer will determine the necessity for Overhaul. The contractor shall give the engineer ample time to take the necessary cross-sections and measurements to determine the volume of excavation for which Overhaul is paid.
- (4) The engineer will not measure overhaul for the disposal of surplus or unsuitable material.

205.4.3 Presplitting Rock

- (1) The department will measure Presplitting Rock by the linear foot of drill holes, including test section holes, drilled along the face of acceptable presplit rock slopes. The department will take the measurement from the top of the drill hole at the rock surface to the elevation of the roadway ditch, to a predetermined bench elevation or to the bottom of the rock ledge or mass where the rock does not extend to the roadway ditch or predetermined bench elevation. The department will not include overbreak quantities in the measurement of Excavation Rock where presplitting is used.

205.5 Payment

205.5.1 General

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
205.0100	Excavation Common	CY
205.0200	Excavation Rock	CY
205.0300	Excavation Stone Piles and Stone Fences	CY
205.0400	Excavation Marsh	CY
205.1200	Overhaul	YDMI
205.1300	Presplitting Rock	LF

205.5.2 Excavation

- (1) Payment for the Excavation bid items under this section is full compensation for all work specified for those excavation classes under section 205 for which no separate unit prices are included in the contract. Except as specified otherwise in [section 203](#) and [section 204](#) for removing concrete structures, and below for performing EBS after completing rough grading operations. The cost of removing walls, foundations, etc., the satisfactory disposal of resulting material, and the backfilling of basements or openings resulting from removing walls, foundations, etc., for which no separate unit prices are included in the contract, is included in the contract unit price for the Excavation bid items, except for removing concrete structures. The department will not make additional payment for this work, except the department will pay separately for providing the required granular backfill under the Backfill Granular bid item, and, except as specified above for removing concrete structures and EBS performed after completing rough grading. The contract unit price shall include all haul except as outlined for overhaul in [205.3.16](#).
- (2) The department will only pay for engineer-approved EBS to correct problems beyond the contractor's control. Work performed under [105.3](#) to correct unacceptable work is the contractor's responsibility. For EBS work performed before rough grading is complete in the EBS area, the department will pay for EBS at the contract price under the pertinent excavation and backfill bid items. For EBS work requiring the contractor's return, performed before placing subbase or base but after rough grading is complete and the grade is ready for blue tops in the EBS area, the department will pay for EBS as follows:
1. For excavation; 3 times the contract unit price for the Excavation Common bid item under the EBS Post Grading administrative item.
 2. For backfill with the materials the engineer directs; at the contract unit price for the bid items of each material used to fill the excavation.
 3. For excavation or backfill without contract bid items; as extra work.
- (3) If the contract does not include the Excavation Rock bid item, the department will pay 5 times the contract bid price of the Excavation Common bid item to remove boulders having volumes of one cubic yard (1 m³) or more. The department will pay for these boulder removals under the Removing Large Boulders administrative item.
- (4) Constructing and removing all temporary drainage installations as specified under [205.3.3](#) is incidental to the work under this section.
- (5) The department will pay for erosion control, fertilizing, and seeding of material disposal sites as specified for under material disposal sites in [628.5.12](#).
- (6) The department will pay for refilling and compacting washouts caused by erosion under the contract bid item for the additional volume of material used, or as extra work according to [107.14](#), except that if the erosion is caused by the contractor's negligence then the contractor performs refilling and compaction at no expense to the department.

205.5.3 Overhaul

- (1) Payment for Overhaul on roadway and drainage excavation, agreed upon in writing by the contractor and engineer before the work is started, is full compensation for all labor, equipment, tools, and incidentals necessary due to the additional haul or transportation involved beyond free haul limits as defined in [205.4.2](#).
- (2) The department will not pay for overhauling surplus or unsuitable materials from roadway and drainage excavation that the contractor disposes of.

- (3) If the engineer requires the contractor to secure additional excavation outside the balance division, but within the limits of the right-of-way, the department will measure and pay for this material under the appropriate Excavation bid items in the contract, and pay for all transportation and hauling of this material over a distance of 2000 feet (600 m) under the Overhaul bid item.

205.5.4 Presplitting Rock

- (1) Payment for Presplitting Rock is full compensation for all drilling, charging, stemming, and blasting; and for providing all materials, including explosives.

SECTION 206 EXCAVATION FOR STRUCTURES

206.1 Description

- (1) This section describes excavating for culverts, structural plate pipe, and structural plate pipe arches, bridges, and retaining walls. It also describes removing old substructure units within the space occupied by the new structure.

206.2 Materials

- (1) Furnish backfill material of a quality acceptable to the engineer and free from frozen lumps, wood, or other extraneous or perishable material. The contractor may use engineer-approved material obtained from excavation.
- (2) If the contract specifies structure backfill, furnish material conforming to [section 210](#). The contractor may use material conforming to the requirements for structure backfill obtained from excavation as specified under [104.8](#).

206.3 Construction

206.3.1 General

- (1) Under the Excavation for Structures bid items, excavate all material of whatever nature encountered. The department will not classify this excavation as common, rock, or marsh excavation under section 205 or as dry or wet excavation.
- (2) Remove all logs, stumps, and other materials and obstructions necessary to place the foundations and structure. Dispose of all material obtained from excavation. Backfill, compact, shape, slope, and clean the site.
- (3) Construct, and subsequently remove, all necessary cofferdams and cribs or well-point systems, and the necessary sheeting, shoring, bracing, draining, and pumping to allow constructing the substructure, above the seal, in the dry. Do not use stream diversions and earth dikes instead of specified cofferdams or well-point systems, unless the engineer authorizes in writing.

206.3.2 Excavation Depth

- (1) The elevation of the bottoms of footings, as the plans show, is approximate only. The engineer may order, in writing, changes in dimensions or elevation of footings necessary to secure a satisfactory foundation.

206.3.3 Cofferdams and Cribs

- (1) If providing cofferdams and cribs for foundation construction, ensure that they are safely designed and constructed, carried to adequate depths and heights, and are made watertight as necessary for the proper performance of the work. Construct cofferdams and cribs so that interior dimensions give sufficient clearance for the construction of forms and the inspection of their exteriors, and to allow pumping from sumps outside the forms. If cofferdams or cribs tilt or move laterally during the process of sinking, right, reset, or enlarge them to provide the necessary clearance at no expense to the department. The contractor is responsible for any claims for damages resulting from the use of a well-point system.

206.3.4 Protecting Concrete

- (1) Construct cofferdams and cribs to protect fresh concrete against damage from a sudden rising of the stream and to prevent damage to the foundation by erosion. Place wales and cross braces at locations that allow construction of the substructure unit without construction joints other than those the plans show. If required to leave wales or braces in place, use only pipe, precast concrete or rolled steel sections. Do not box out with timber braces.

206.3.5 Plans Required

- (1) If the engineer requests, submit one copy of signed and sealed plans as specified for cofferdams and cribs under [105.2](#), showing the proposed method of cofferdam or crib construction for the file. At the engineer's request, submit 2 additional copies of these plans for review. If the engineer does not find the plans submitted for review satisfactory, make the required changes. Whether or not the engineer requests submittal of the plans or concurs in the use of the plans as submitted or corrected, the department will not relieve the contractor of the responsibility to secure a safe and satisfactory cofferdam or crib.

206.3.6 Removal

- (1) Unless specified otherwise, remove cofferdams or cribs, including all sheeting and bracing, after the completion and curing of the substructure unit. Exercise care not to disturb or otherwise injure the finished masonry.

206.3.7 Excavation

- (1) Notify the engineer sufficiently before beginning excavation for structures so the engineer may take elevations and measurements of the existing ground and substructure units before disturbance and removal.
- (2) Excavate as specified in 29 CFR Part 1926 OSHA subpart P for excavations. Slope the sides of the excavation as required by soil conditions to stabilize the sides for safe working conditions. Limit excavation to the amount considered necessary for safety. If the plans require, shore the excavation instead of sloping the sides. If the plans do not require shoring, the contractor may elect to use, at no expense to the department, shoring rather than excavating to a slope.

206.3.8 Preparing Foundation for Footings

- (1) Free rock or other hard foundation material of all loose material. Clean and cut this material to a firm surface, either level, or stepped, or serrated. Clean out and fill all seams with cement mortar or grout.
- (2) If masonry is to rest on an excavated surface other than rock, exercise special care not to disturb the bottom of the excavation. Do not make the final removal of the foundation material to grade until just before placing the masonry. Protect surfaces from freezing after excavation and before placing concrete for the footing.
- (3) If using foundation piles, substantially complete the excavation of each pit before beginning pile-driving operations in the pit. After completing pile-driving operations in a given pit, remove all loose and displaced material in the pit to the elevation of the bottom of the footings.
- (4) If the contractor can place footings in dry foundation pits, it may omit footing forms, with the engineer's approval. In this case, fill the entire excavation with concrete to the elevation of the top of the footing.
- (5) For footings founded on sound rock, key them into the rock as the plans require. If required, conform the keyway to plan dimensions. For footing excavations in sound rock, fill the footing with concrete to the elevation of the top of the rock or the top of the footing, whichever is lower.

206.3.9 Dewatering

- (1) If possible, dewater foundation excavations before depositing masonry within.
- (2) Pump from the interior of foundation enclosures in a manner to preclude, if it is practical, removing foundation material or concrete ingredients.
- (3) Do not pump from the interior of a foundation enclosure while placing concrete in the enclosure or for at least 24 hours afterwards, unless done from a suitable sump outside the forms. Do not pump from within any foundation enclosure while depositing concrete under water in the enclosure. Do not begin pumping to dewater a sealed cofferdam until the seal has set sufficiently to withstand the hydrostatic pressure, or until at least 3 days have elapsed since placing the seal.

206.3.10 Subfoundation Course

206.3.10.1 Bridges and Retaining Walls

- (1) If placing masonry on a soft, muddy, or muck-covered surface that will not dry out and harden if the excavation is kept dewatered for a reasonable length of time, furnish and place a subfoundation course if directed by the engineer. Construct a subfoundation course of structure backfill conforming to [section 210](#), or other engineer-approved materials. Place the subfoundation course directly below the elevation of the bottom of the footings to the depth designated by the engineer.

206.3.10.2 Culverts

- (1) Place a 6 inch (150 mm) subfoundation course of structure backfill conforming to [section 210](#), or other engineer-approved materials, directly below the elevation of the bottom of the slab between the cutoff walls of all culverts.

206.3.10.3 Structural Plate Pipe and Pipe Arches

- (1) Place subfoundation courses, including cushion courses, for structural plate pipe and pipe arches as specified for erection in [527.3.2](#).

206.3.11 Foundation Seal

- (1) If the contractor encounters conditions that make it impractical to dewater the foundation excavation before placing the masonry, the engineer may require construction of a concrete foundation seal of necessary dimensions. After the seal sets, dewater the foundation excavation and place the balance of the masonry in the dry. Place foundation seals the plans do not show below the bottom of the footing shown on the plan, unless authorized otherwise. Place concrete in foundation seals as specified for depositing concrete underwater in [502.3.5.3](#).

206.3.12 Inspection

- (1) Do not place any masonry or erect any form or structural plate pipe or pipe arch in any excavation until the engineer approves the depth of the excavation and the character of the foundation material.

206.3.13 Backfilling

206.3.13.1 General

- (1) Backfill all spaces excavated and not occupied by the new structure to the elevation and section existing before excavation. Do not place backfill above the required section for the finished work. If placing backfill, provide allowance for settlement.
- (2) Do not backfill substructure units, except as required for the safety of workers, until clearing the area involved of all falsework, sheet piling, cribbing, shoring, bracing, forms, and rubbish. Backfill the cofferdams before removing the sheeting, unless the engineer allows otherwise.
- (3) If required for the safety of workers, and with the engineer's approval, the contractor may remove sheet piling, cribbing, shoring, and bracing as backfilling progresses.
- (4) Perform backfilling to prevent wedging action against the structure. Step, terrace, or treat existing slopes as necessary to prevent slipping and wedging of the backfill.
- (5) Unless specified otherwise, place backfill in continuous horizontal layers no more than 8 inches (200 mm) thick. If practical, uniformly raise layers on all sides of each substructure unit or culvert. Surround the stone used in backfilling by finer material. Compact each layer, before placing the next layer, by using engineer-approved rollers or portable mechanical or pneumatic tampers or vibrators.
- (6) If there is water in an excavation, perform backfilling so that backfill displaces the water and does not trap it within. Do not use water to expedite backfill settlement except with the engineer's written approval. However, the engineer will not require the contractor to dewater the excavation before placing backfill. If allowed to use water, keep the entire excavation inundated while placing backfill, except if jetting.
- (7) Conduct backfilling operations to avoid damage or deflecting any portion of the structure out of alignment. Gradually deposit the backfilling material transported in trucks or other vehicles instead of dumping the entire contents as one mass. Lower all clams, dippers, and similar backfill containers to within 5 feet (1.5 m) of previously deposited backfill, or of the water surface, before dumping.
- (8) The contractor may end dump backfill from the structure or approach embankment if it intends to spread and place the end-dumped material in the above-described 8-inch (200 mm) horizontal layers. Do not place backfill in or from narrow ramps or driveways up to or from the structure.
- (9) Perform backfilling around structural plate pipe and pipe arches as specified for backfilling around pipe and pipe arches under [527.3.3](#).
- (10) Extend the backfill along the front face of abutments, retaining walls, and wing walls to within 6 inches (150 mm) of the weep holes, unless designated otherwise.
- (11) If weep holes are designated on the plans for culverts, abutments, and retaining walls, deposit coarse gravel or broken stone behind the culvert, abutment, or retaining wall at the level of the weep holes according to dimensions the plans show.
- (12) Do not place backfill against any portion of any substructure unit until completing the required curing, surface preparation, dampproofing, and waterproofing of the work to be backfilled.

206.3.13.2 Self-Supported Abutments and Retaining Walls

206.3.13.2.1 General

- (1) Allow self supported structures to develop sufficient strength before backfilling.

206.3.13.2.2 Backfill on One Side of the Structure

- (1) The contractor may backfill structures that have attained the specified compressive strength or upon expiration of the minimum time periods tabulated below:

STRUCTURE TYPE ^[1]	GENERAL PURPOSE CONCRETE in days ^[2]	HIGH EARLY STRENGTH CONCRETE in days ^[2]	COMPRESSIVE STRENGTH in psi (MPa)
Abutment type A1, A2, A5 ^[4]	2	1	2000 (13.8)
Abutment type A3 ^[3]	2	1	2000 (13.8)
Abutment type A4	14	7	3000 (20.7)
Full retaining abutments	14	7	3000 (20.7)
Box culverts ^[5]	14	7	3000 (20.7)
Retaining walls and end walls	14	7	3000 (20.7)

^[1] Abutment types:

A1: Body about 5 feet (1.5 m) tall with one row of piles.

A2: Body about 5 feet (1.5 m) tall with 2 rows of piles.

A3: Body about 5 feet (1.5 m) tall with backwall and 2 rows of piles

A4: Body about 13 feet (4 m) tall with backwall and 2 or more rows of piles.

A5: Body about 10 feet (3 m) tall with one row of piles extending to within 2 feet (0.6 m) of abutment top.

Full retaining: Body extending from lower roadway/river elevation to beam seats.

^[2] Only count days where the concrete temperature did not fall below 40 F (4 C).

^[3] Upon obtaining the required compressive strength, the contractor may backfill the body of A3 abutments before placing the backwall.

^[4] Place and cure the superstructure before backfilling A5 abutments as specified in 206.3.13.3.

^[5] Place and cure the top before backfilling except as allowed under 206.3.13.3.

206.3.13.2.3 Backfill on Both Sides of the Structure

- (1) The contractor may backfill footings to the top of the footings; sill abutments to the berm elevation; and retaining walls and piers uniformly and simultaneously on both sides to the elevation of the front ground surface immediately upon removing the forms.

206.3.13.3 Rigid Frame Structures

- (1) Do not place backfill against an abutment or wall designed to gain support from a superstructure until placing and curing that superstructure.
- (2) The contractor may backfill 1/4 of the total wall height of a box culvert after attaining a wall compressive strength of 2000 psi (13.8 MPa). Do not complete the backfill until the top is placed and conforms to 206.3.13.2.2.

206.3.14 Incorporating or Disposing of Excavated Material

- (1) Incorporate excavated material in the work to the extent that it is practical. Use materials with suitable engineering properties for riprap or backfill. If the contract contains the Excavation Common or Borrow bid items and embankment material is needed at the time of disposal, use the balance of the excavated material, with suitable engineering properties, in the embankment.
- (2) Dispose of surplus or unsuitable material as specified in [205.3.12](#).

206.3.15 Preserving Channels and Waterways

- (1) Unless otherwise allowed, do not excavate outside caissons, cribs, cofferdams, or sheet piling, and do not disturb the natural streambed next to the structure. If performing any excavation or dredging at the site of the structure before caissons, cribs, or cofferdams are sunk in place, backfill these excavations to the original ground surface or stream bed with material satisfactory to the engineer after placing the foundation.
- (2) After completing work within cofferdams, cribs, or sheet piling, backfill excavated areas within the cofferdams to the stream bed elevation, unless specified otherwise.
- (3) Remove excavated material and debris resulting from the contractor's operations from stream channels, ditch lines, or waterways to the level of the finished streambed or ground line at no expense to the department.

206.4 Measurement

- (1) The department will measure the Excavation for Structures bid items as a single lump sum unit for each structure acceptably completed.
- (2) The department will measure the Cofferdams bid items as a single lump sum unit for each cofferdam acceptably completed.

206.5 Payment

206.5.1 General

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
206.1000	Excavation for Structures Bridges (structure)	LS
206.2000	Excavation for Structures Culverts (structure)	LS
206.3000	Excavation for Structures Retaining Walls (structure)	LS
206.4000	Excavation for Structures Structural Plate Pipe or Pipe Arches (station)	LS
206.5000	Cofferdams (structure)	LS

- (2) The department will pay for material excavated under this section and used in embankments at the contract unit price for Borrow, or absent the Borrow bid item, at the contract unit price for Excavation Common. The department will measure material as specified for excavation in [205.4.1](#).
- (3) The department will pay separately for foundation seals, the plans show or the engineer directs, under the Concrete Masonry Seal bid item as specified in [502.5](#).

206.5.2 Excavation for Structures

- (1) Payment for the Excavation for Structures bid items is full compensation for removing and disposing of all excavation, including excavating for seals, girders, projections, and subfoundation courses; for preparing foundation; and for backfilling and compacting all space excavated and not occupied by the new structure, including subfoundation course.
- (2) Payment also includes providing cofferdams, cribs, sheeting, shoring, bracing, pumping, and dewatering except, if the contract contains the applicable bid items, the department will pay separately for this work.
- (3) Payment is full compensation for all excavation, removed to an elevation between planes one foot (300 mm) above and below the plan elevation of the bottom of the footings or floor of culverts, or the invert of structural plate pipe or pipe arches as the plans show for the specific units.
- (4) If the footing is stepped, or on a slope, payment is full compensation for all excavation to an elevation between planes lying one foot (300 mm) above and below the plan elevation of the bottom of the footing, for each stepped section; or all excavation between planes lying one foot (300 mm) above, below, and parallel to the slope established by the plan elevations for the bottom of the footing.
- (5) If the engineer orders any excavation be performed to elevations in excess of one foot (300 mm) above or below the elevation of the bottom of the footings or floor or invert as indicated on the plans, the department will pay for this excavation as extra work.
- (6) The department will pay separately for all necessary clearing and grubbing under the Clearing and Grubbing bid items as specified in [201.5](#).

- (7) The department will pay separately for structure backfill, if specified, under the Backfill Structure bid item as specified in [210.5](#).

206.5.3 Cofferdams

- (1) Payment for the Cofferdams bid items is full compensation for providing all cofferdams and cribs, including well-point systems, sheeting, shoring, and bracing; for constructing, maintaining, backfilling, and removing cofferdams and cribs; and for pumping and dewatering.

SECTION 207 EMBANKMENT

207.1 Description

- (1) This section describes placing in embankments and in miscellaneous backfills, material obtained under the bid items in the roadway and drainage excavation, borrow, or excavation for structures sections.

207.2 Materials

- (1) For embankment, use engineer-approved material containing no logs, stumps, brush, or other perishable material. The contractor may place excess unstable topsoil and other unstable soil in embankments outside the roadway foundation as defined in [101.3](#). Do not place frozen soil in embankments within the roadway foundation.
- (2) For the top 8 inches (200 mm) of earth embankments, use materials that are free from large stone, rock, and broken concrete or other materials that significantly affect scarifying, compacting, and finishing the subgrade.
- (3) For those portions of embankments that the contractor proposes to bore holes for piling, or to drive piling through, use materials that do not contain stone or broken concrete retained on a 3 inch (75 mm) ring and that are free from quantities of gravel, stone, or broken concrete passing a 3 inch (75 mm) ring or other material that significantly affects boring the holes or driving the piling.

207.3 Construction

207.3.1 General

- (1) Before placing embankment materials, complete any required clearing and grubbing of the site and prepare the roadway foundation as specified in [205.3.2](#), unless the contract specifies otherwise.
- (2) Remove ice and snow from the ground surface before placing embankment on the ground.
- (3) Unless the contract specifies otherwise, discontinue constructing embankments in the fall or early winter if weather conditions prevail that cause substantial freezing of the materials during placement, except if using materials from rock excavation, or of a granular nature and that contain only minor quantities of silt, clay, loam, or similar materials.

207.3.2 Placing Layers

- (1) Construct an embankment starting at the lowest point of the fill, below the grade at the bottom of ravines. Construct the embankment in layers by spreading and leveling the material during placement. Spread individual layers evenly to uniform thickness throughout and approximately parallel with the finished grade for the full width of the embankment, unless directed otherwise. Place the material in layers generally no thicker than 8 inches (200 mm), to secure the required compaction. On side hills too steep to operate hauling equipment, over low wet ground, in marshes, or if filling in water, provide a single layer, just thick enough to support the hauling equipment while placing subsequent layers.

207.3.3 Placing in Marsh

- (1) If constructing embankments in trenches excavated across wet marshes or swamps, end dump the fill material. Begin filling at one end of the marsh and proceed across the marsh, close enough to the excavating operations to allow the equipment to remove any displaced peat or muck as it accumulates ahead of the advancing embankment toe. Place fill material in a manner that, and to a height that, effectively displaces unstable material from within the area of the proposed embankment. Build temporary surcharges, as required, to the height and horizontal dimensions the plans show. Progressively move temporary surcharges ahead as the embankment advances.
- (2) If excavating marsh areas in a dry condition, construct the embankment in the excavation area in layers and compact it to the extent that it is practical.

207.3.4 Placing Rock

- (1) If the material for embankment consists of rock, broken stone, or fragmented material of a size that makes placing in 8 inch (200 mm) layers not practical, then place the embankment material in layers no thicker than the approximate average size of the larger rocks. Avoid nesting and fill all the voids with smaller stones and satisfactory soil or rock fines.

207.3.5 Hydraulic Fills

- (1) If constructing embankments by the hydraulic method, obtain the engineer's written approval as specified in [208.3](#) and construct as the engineer directs.

207.3.6 Compaction

207.3.6.1 General

- (1) Except as specified otherwise for backfilling wet marshes, constructing rock fills, and hydraulic fills, compact all embankments using standard compaction methods unless the contract specifies special compaction.
- (2) Do not compact embankment material if the moisture content causes excessive rutting by the hauling equipment, or excessive displacement or distortion under the compacting equipment. If these conditions exist, allow the materials to dry before compacting. If necessary, accelerate drying the materials by aerating or by using blade graders, harrows, discs, or other appropriate equipment to manipulate the material.
- (3) If the embankment material does not contain sufficient moisture to compact properly, add water in quantities the engineer deems necessary to aid, accelerate, and secure effective compaction.
- (4) Compact embankments, outside the roadway foundation, to the degree contemplated for standard compaction. The engineer may allow less compaction outside the roadway foundation if the contractor uses unstable soil.

207.3.6.2 Standard Compaction

- (1) Deposit, spread, and level, as specified above, the embankment material in layers generally no thicker than 8 inches (200 mm) before compaction. Compact each layer of the embankment until the compaction equipment achieves no further significant consolidation. Provide the required compaction for each layer before placing any material for a succeeding layer.
- (2) Use specialized compaction equipment supplemented by routing, hauling, and leveling equipment over each layer of the fill to make use of the compaction capabilities of this equipment. The engineer may waive the requirement for specialized compaction equipment if, in the engineer's opinion, the hauling and leveling equipment will achieve satisfactory compaction.
- (3) Specialized compaction equipment includes tamping rollers, pneumatic-tire rollers, vibratory rollers, or other alternate compaction equipment that produces the required results. Obtain the engineer's approval before using alternate compaction equipment.
- (4) For tamping rollers, use equipment that exerts at least 150 pounds per square inch (1030 kPa) of pressure on the tamping surface of each tamping foot in a transverse row.
- (5) Use pneumatic-tire rollers or other equipment that have a weight of not less than 150 pounds per linear inch (2680 kg/m) of overall rolling width.

207.3.6.3 Special Compaction

- (1) Upon the properly prepared ground surface, deposit, spread, and level, as specified above, the embankment material in layers generally not exceeding 8 inches (200 mm) in thickness before compaction. If compacting granular material with equipment adaptable for this purpose, the contractor may increase layer thickness to 12 inches (300 mm) if obtaining the required dry density. Except as specified for construction methods in [207.3.2](#), [207.3.3](#), [207.3.4](#), and 207.3.5, compact each layer of spread and leveled material by suitable compaction equipment, to not less than the specified dry density before placing the succeeding layer.
- (2) Compact the roadway foundation to at least the dry density specified in 207.3.6.3(3). Compact embankment areas outside the roadway foundation as specified in 207.3.6.1(4).
- (3) For embankments of 6 feet (1.8 m) or less high or for portions occurring within 200 feet (60 m) of a bridge abutment, compact the full depth of the embankment to at least 95 percent of maximum dry density. For embankments over 6 feet (1.8 m) in height, compact the material placed 6 feet (1.8 m) below the finished subgrade to at least 90 percent of maximum dry density and backfill material placed within 6 feet (1.8 m) of the finished subgrade to at least 95 percent of maximum dry density.
- (4) The engineer will determine the maximum dry density according to AASHTO T 99, Method C, except, replace the fraction of material retained on the 3/4 inch (19.0 mm) sieve with No. 4 (4.75 mm) to 3/4 inch (19.0 mm) material. The engineer will determine the in-place dry density of compacted embankment material according to AASHTO T 310 or by other engineer-approved methods.

- (5) If the material in the in-place density sample differs in percentage of aggregate retained on a No. 4 (4.75 mm) sieve from the sample that the maximum dry density was determined from, the engineer will adjust the maximum dry density according to approved department procedure.
- (6) The engineer will not apply the foregoing density requirements to portions of embankments constructed of materials that, because of numerous large stones or high percentages of material retained on the No. 4 (4.75 mm) sieve, the engineer cannot accurately test according to the above procedures for determining maximum dry density or in-place dry density.

207.3.6.4 Subgrade Compaction in Cuts

- (1) Compact the finished earth subgrade in cut sections for a width equal to the width of the proposed pavement plus shoulders as specified for standard compaction in [207.3.6.2](#), unless the contract specifies using special compaction.
- (2) On grading projects that require special compaction, compact the finished earth subgrade in cut sections to the width described in 207.3.6.4(1) and to a depth of at least 6 inches (150 mm) to at least 95 percent of maximum density. The engineer will determine the maximum density and attained density in the subgrade as specified for special compaction under [207.3.6.3](#).

207.3.7 Shrinkage and Surcharge

- (1) If the engineer considers it necessary, build embankments to an elevation above required grade to allow for settlement; or place sufficient surcharge above the required elevation of earth grade over deposits of unstable material to secure displacement or settlement.

207.3.8 Slopes

- (1) Build embankment slopes to the lines and section the plans show or as directed by the engineer. For slopes of rock fill embankments, completely fill all voids with rock fines or soils, and trim slopes to a smooth uniform appearance.
- (2) Construct embankments, whose slopes are receiving topsoil or salvaged topsoil, so that after placing the topsoil the finished embankment conforms to the required section.

207.3.9 Subgrade Intermediate Consolidation and Trimming

- (1) In addition to maintaining drainage during construction as specified in [205.3.3](#), at the end of each work day consolidate and trim the subgrade to aid drainage and to protect against erosion. Use equipment conforming to [207.3.6.2](#) to consolidate and trim those portions of the subgrade surface disturbed, operated over, or constructed during that workday. Consolidate and trim until all float material is pressed firmly against the subgrade and produces a tight, smooth, well-drained surface. If rain is imminent during the workday, consolidate and trim the subgrade before the rain falls to avoid ponding and erosion.

207.3.10 Backfilling Structures

- (1) Place and compact all required embankments over and adjacent to all culverts, bridges, retaining walls, and other structures. This includes backfilling not performed incidental to the excavation of these structures.
- (2) Use materials and construction methods specified for backfill in [206.3.13](#).
- (3) If special compaction is specified, compact backfill material placed 6 feet (1.8 m) or more below the finished subgrade to at least 90 percent of maximum density and backfill material placed within 6 feet (1.8 m) of the finished subgrade to at least 95 percent of maximum density. For bridge approaches, compact as specified in [207.3.6.3](#).

207.3.11 Finish Grading

- (1) Trim, finish, and maintain earth grade as specified for finish grading under [205.3.13](#).
- (2) The engineer may require the removal and disposal of rock, stone, and boulders excavated by plowing and scarifying.

207.4 Measurement

- (1) The department will not directly measure work under this section.

207.5 Payment

- (1) The department will not pay directly for work specified under this section. This work is incidental to the bid items under the roadway and drainage excavation, borrow, excavation for structures, granular backfill, structure backfill sections, and other contract bid items. The work includes forming, compacting, shaping, sloping, trimming, finishing, maintaining the embankments, and all other incidental work required under this section.
- (2) The department will not pay separately for removing and disposing of rock, stone, and boulders that the engineer rejects under [207.3.11](#).

SECTION 208 BORROW

208.1 Description

- (1) This section describes furnishing, excavating, hauling, and placing engineer-approved material, required for completing embankments and other portions of the work, obtained from outside the limits of the bid items under the roadway and drainage excavation or the excavation for structures sections, and other contract-designated excavation, when sufficient quantities of material with suitable engineering properties are not available within these limits.

208.2 Materials

208.2.1 Quality

- (1) Under the Borrow bid item, furnish material consisting of satisfactory soil or a mixture of satisfactory soil, stone, gravel, or other acceptable materials, of a character and quality satisfactory for the purpose intended. Use material free from sod, stumps, logs, and other perishable and deleterious matter.
- (2) For selected borrow excavation furnish material conforming to the quality requirements specified in the contract.

208.2.2 Source

- (1) Obtain material from engineer-approved sources that the contractor provides, from state-furnished sources outside the right-of-way limits of the project, or from projects included under the contract.
- (2) Unless the contract specifies otherwise, the contractor shall negotiate with property owners or others from whom the contractor proposes to obtain borrow material. Remove material from and provide the final condition of the pit as specified for final cleanup in [104.9](#) and 208.3.
- (3) If the engineer authorizes in writing, the contractor may obtain suitable surplus excavation from other projects, or material from old road fills, removed as specified in [section 214](#).

208.3 Construction

- (1) Clear and grub the area for the borrow pit in the same manner specified for roadway and drainage excavation. Remove all sod or other perishable or unsuitable material from the proposed pit area. Excavate borrow pits in a manner that allows the engineer to accurately measure the material excavated and incorporated in the work.
- (2) Dispose of all stone, broken rock, boulders, and other materials unsuitable for use in the work as specified in [205.3.12](#).
- (3) Dispose of all stumps, trees, logs, brush, tops, and other debris resulting from clearing and grubbing work in borrow pit areas as specified in [201.3](#).
- (4) Except for commercial pits, strip off the available topsoil, or other soil favorable to plant growth, overlying the borrow pit. Stockpile the topsoil in sufficient quantities to cover all surfaces of excavated areas from 4 inches to 6 inches (100 to 150 mm) deep. If the topsoil overlying the pit is less than 4 inches (100 mm) deep, replace the topsoil to the original depth. After trimming and finishing the pit, spread the salvaged material uniformly over all excavated areas of the borrow pit, unless the engineer authorizes otherwise in writing.
- (5) Restore the excavated areas of the pit, adjacent disturbed areas, and associated haul roads as follows:
 1. Fertilize as specified in [section 629](#) and seed as specified in [section 630](#) unless the landowner elects otherwise under [630.3.3.3](#).
 2. Install erosion control devices conforming to the ECIP developed under [107.20](#).
- (6) The contractor may place borrow, or select borrow, by hydraulic methods. If the contractor elects to do this, it shall obtain the engineer's written approval covering the quality and sources of the proposed material and the proposed construction methods before proceeding.

208.4 Measurement

- (1) Except for hydraulic fills, the department will measure Borrow or Select Borrow by the cubic yard acceptably completed. The department will measure the borrow quantity in its original position in the source pit. The department will compute this volume by the method of average end areas, with no correction for curvature, or if the engineer elects, by the method of truncated prisms. The engineer and contractor may agree to an alternate calculation method.

- (2) The contractor shall give the engineer sufficient notice before performing excavation operations so the engineer has time to accurately measure the borrow pit. The department will not measure sod or other unsuitable material removed, or material salvaged from borrow pits and used for covering surfaces of the excavated areas within the pits, as specified above. The engineer may require the contractor to remove topsoil or other unsuitable materials from the surface of the pit area before taking original cross sections of the pit area and, upon completing the excavation, to smooth or trim the pit, as required, to allow taking accurate final measurements of the area before replacing the topsoil. The department will not measure any material excavated before the engineer staked out and cross sectioned the borrow pit, and all material excavated in excess of that required for, or not incorporated in the work.
- (3) If placing a quantity of Borrow or Select Borrow of an amount so minor, that in the engineer's judgment, its measurement by the above method is impractical, the engineer will measure this minor quantity by the cubic yard in the vehicle. The engineer will determine the capacity of each vehicle used for hauling the material to the nearest 1/10 cubic yard (0.1 m³).
- (4) If the contractor elects, or the contract requires to use hydraulic methods for placing embankments, the department will measure Borrow or Select Borrow by the cubic yard of compacted embankment acceptably completed, measured by the method of average end areas, with no correction for curvature. The department will determine the end areas from pre-construction cross sections of the area being covered by the proposed embankment and from cross sections of the completed work. The department will not make allowances for shrinkage, subsidence, lateral movement of the material, or for material in excess of that required for work the plans show or the engineer orders.

208.5 Payment

- (1) The department will pay for measured quantities at the contract unit prices under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
208.0100	Borrow	CY
208.1100	Select Borrow	CY

- (2) Payment for Borrow and Select Borrow is full compensation for providing all borrow material; for all clearing, grubbing, excavating, sloping, shaping, trimming, loading, hauling, placing; compacting; disposing of surplus and unsuitable material; and for salvaging, stockpiling, rehandling, and spreading salvaged material for covering the surfaces of excavated areas within borrow pits.
- (3) Payment also includes water for compaction and dust control except, if the contract contains the Water bid item, the department will pay separately for compaction and dust control water under [624.5](#).
- (4) The department will pay for erosion control, fertilizing, and seeding of borrow pits and associated areas separately as specified for borrow sites and material disposal sites in [628.5.12](#).

SECTION 209 GRANULAR BACKFILL

209.1 Description

- (1) This section describes furnishing processed or selected materials for backfilling, where the plans designate, as follows:
 1. Excavations for frost heave or other unstable materials.
 2. Trenches for pipe culverts, storm sewers, underdrains, and similar structures.

209.2 Materials

209.2.1 General

- (1) Furnish natural sand or a mixture of sand with gravel, crushed gravel, crushed stone, or other broken or fragmented material.
- (2) For backfill for trench excavation, use a maximum size of any gravel, stone, or other broken or fragmented material so that 100 percent passes a 6 inch (150 mm) sieve, not less than 85 percent by weight passes a 3 inch (75 mm) sieve, and not less than 25 percent by weight passes a No. 4 (4.75 mm) sieve. For bedding under a culvert pipe, use granular backfill that consists substantially of sand with all particles retained on a one-inch (25.0 mm) sieve removed.
- (3) Conform to the definitions under [301.2.1](#).
- (4) Use either grade 1 or grade 2 material, unless the contract specifies otherwise.
- (5) Do not use materials with a liquid limit greater than 25 and a plasticity index greater than 6.

209.2.2 Gradation of Material Passing the No. 4 Sieve

- (1) For material passing the No. 4 (4.75 mm) sieve, conform to the following:

SIEVE SIZE	MAXIMUM PERCENT PASSING BY WEIGHT	
	GRADE 1	GRADE 2
No. 4 (4.75 mm)	100	100
No. 40 (425 µm)	75	_____
No. 100 (150 µm)	15	30
No. 200 (75 µm)	8.0	15.0

209.2.3 Sampling and Testing

- (1) The department will sample and test granular backfill according to the following:

Sampling ^[1]	AASHTO T 2
Percent passing the 200 (75 µm) sieve ^[1]	AASHTO T 11
Gradation ^[1]	AASHTO T 27
Liquid limit	AASHTO T 89
Plasticity index and plastic limit	AASHTO T 90

^[1] As modified in CMM 13.

- (2) The department may sample and test using other engineer-approved field methods.

209.2.4 Source

- (1) Except as specified for materials utilized from roadway excavation under [104.8](#), the contractor is responsible for negotiating with property owners to obtain structure backfill material.
- (2) Remove the granular backfill material and restore the pit to a final condition as specified for final cleanup and material disposal under [104.9](#) and [208.3](#).
- (3) In addition to removing the topsoil, substantially remove any overburden of soil, or earthy materials passing the No. 200 (75 µm) sieve before excavating the granular backfill material.
- (4) If the department measures granular material for payment in its original position, trim and shape pits after removing overburden and before removing granular material to allow taking accurate measurements. After removing the required amount of granular material, repeat trimming and shaping of the areas to allow taking accurate measurements.

- (5) Restore the site by replacing or disposing of the removed overburden and ensure that disposal sites are neatly constructed.

209.3 Construction

- (1) If backfilling subgrade excavations, place and compact granular backfill as specified for the construction of embankments in [section 207](#).
- (2) If granular backfill is specified or required for backfilling trenches, place and compact as specified for the construction of work under the applicable specification section.

209.4 Measurement

209.4.1 General

- (1) The department will measure Backfill Granular by the cubic yard acceptably completed. The department will measure this volume either in its original position or in its final position. For minor quantities, the engineer may measure by the cubic yard in the vehicle.
- (2) The department will not measure granular backfill placed outside the designated fill limits or specifically designated as incidental to other contract bid items.

209.4.2 Measured in Original Position

- (1) If measured in its original position, the department will calculate the quantity as specified for borrow in [208.4](#). Prepare the pit for measurement as specified for source under [209.2.4](#).

209.4.3 Measured in Final Position

- (1) If measured in its final position, the department will calculate the quantity by the average end area or truncated prism method. The department will measure material in its final position and compacted condition. The department will only include material within the limits and in the places the plans show, the contract designates, or the engineer directs.
- (2) For areas where the contractor excavates and removes frost heave or unstable materials from the subgrade, the department will compute volume using the dimensions of the plane of the earth subgrade, the depth of the excavation, and the limits of the area that the engineer requires excavated and backfilled.
- (3) For backfilling pipe culverts, the department will compute the volume from the dimensions of the limits of excavation and depth of backfill the plans show or the engineer requires, less the included structure volume.

209.5 Payment

- (1) The department will pay for measured quantities at the contract unit prices under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
209.0100	Backfill Granular	CY

- (2) Payment for Backfill Granular is full compensation for providing all granular backfill material; for excavating, loading, hauling, placing, compacting, and finishing the material; for stripping, clearing, grubbing, shaping, trimming and cleaning up the pits; for salvaging, stockpiling, rehandling, and spreading salvaged material over excavated pit areas; and for disposing of surplus materials.
- (3) The department will not pay separately for granular backfill material specifically designated as incidental to other contract bid items.
- (4) The department will pay for erosion control, fertilizing and seeding of pits and associated areas separately as specified for borrow sites and material disposal sites in [628.5.12](#).

SECTION 210 STRUCTURE BACKFILL

210.1 Description

- (1) This section describes furnishing backfill materials and backfilling excavations for bridges, culverts, retaining walls, and structural plate pipes, and pipe arches. The contract may specify alternate structure backfill materials and methods.

210.2 Materials

210.2.1 General Requirements

- (1) Furnish and use sand, a mixture of sand and gravel, crushed gravel, crushed stone, crushed concrete, or other fragmented mineral material. The maximum material size used shall have 100 percent pass a 3-inch (75 mm) sieve, not less than 25 percent by weight passes a No. 4 (4.75 mm) sieve and, of the material passing the No. 4 (4.75 mm) sieve, not more than 15.0 percent passes a No. 200 (75 µm) sieve.
- (2) Conform to the definitions under [301.2.1](#).

210.2.2 Sampling and Testing

- (1) The department will sample and test structure backfill according to the following:

Sampling ^[1]	AASHTO T 2
Percent passing the 200 (75 µm) sieve ^[1]	AASHTO T 11
Gradation ^[1]	AASHTO T 27

^[1] As modified in CMM 13.

- (2) The department may sample and test using other engineer-approved field methods.

210.2.3 Source

- (1) Except as specified for materials utilized from roadway excavation under [104.8](#), the contractor is responsible for negotiating with property owners to obtain structure backfill material.
- (2) Remove structure backfill material and restore the pit to the final condition as specified for borrow in [208.3](#) and final cleanup in [104.9](#).
- (3) In addition to removing the topsoil, substantially remove any overburden of soil, or earthy materials passing the No. 200 (75 µm) sieve before excavating the structure backfill material
- (4) Restore the site by replacing or disposing of the removed overburden and ensure that disposal sites are neatly constructed.

210.3 Construction

- (1) Place and compact structure backfill material as specified in [206.3.13](#).

210.4 Measurement

- (1) The department will measure Backfill Structure by the cubic yard acceptably completed, measured in the vehicle.

210.5 Payment

- (1) The department will pay for measured quantities at the contract unit prices under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
210.0100	Backfill Structure	CY

- (2) Payment for Backfill Structure is full compensation for providing, placing, and compacting the material; for stripping, clearing, grubbing, shaping, trimming, and cleaning up the pits; for salvaging, stockpiling, rehandling, spreading salvaged material over excavated pit areas; and for disposing of surplus materials.
- (3) The department will pay for erosion control, fertilizing, and seeding of pits and associated areas separately as specified for borrow sites and material disposal sites in [628.5.12](#).

SECTION 211 PREPARING THE FOUNDATION

211.1 Description

- (1) This section describes restoring, correcting, strengthening, or otherwise preparing the pavement foundation to a condition suitable for constructing and supporting a subbase, base, or surface course. Perform the work described in this section whether or not the contract contains the applicable Prepare Foundation bid items.
- (2) The department defines the pavement foundation as the finished earth subgrade, subbase, or base supporting subbase, base, or surface course.

211.2 (Vacant)

211.3 Construction

211.3.1 General

- (1) Prepare and construct the foundation to uniform density throughout. Construct the foundation to the required alignment and cross-section with equipment and methods adapted for the purpose. After shaping and compacting, provide a smooth foundation, at required density, and at the proper elevation and contour, to receive the next course.
- (2) If necessary to properly accomplish blading or to eliminate or prevent conditions of non-uniform stability or density, scarify the area forming the foundation to a uniform depth.
- (3) Unless specified otherwise, fill all holes, ruts, and other depressions in the foundation with materials similar to those existing in the foundation. Excavate and remove high places to the required lines, grade, and section.
- (4) Excavate and backfill areas of yielding or unstable materials with the material the engineer directs.
- (5) The engineer may make minor adjustments in the plan finished grade line necessary to maintain the characteristics of a stabilized foundation by minimizing the amount of cutting into, or filling over the stabilized foundation, provided these adjustments do not impair the riding qualities, drainage, or appearance of the finished pavement or cause, in effect, a deviation from a grade established by appropriate municipal ordinance.
- (6) Prepare the foundation to conform to the specifications for the specific subbase, base, or surface course constructed.

211.3.2 Earth Subgrade

- (1) If the foundation is an earth subgrade, constructed under this contract or under a previous contract, prepare or restore the foundation by removing all vegetation; excavating and removing materials of any nature encountered above the required elevations; filling all depressions occurring below the required elevations; and smoothing, shaping, and compacting the subgrade to the required grade, section, and density.
- (2) Scarify the subgrade to a depth necessary for the type of material encountered. Shape and compact the subgrade to the required lines, grade, cross-section, and uniform density. Remove stones over 6 inches (150 mm) in greatest dimension encountered during the operations.
- (3) If the earth subgrade construction was substantially completed under a previous contract, do not presume that the previously completed work conforms to the requirements under this section.

211.3.3 Foundation for Non-Rigid Base

- (1) Prepare the foundation by scarifying, blading, leveling, and rolling as required to bring the foundation to the required grade, cross-section, and density. Shape and compact the foundation for the full width of the roadbed, to the required lines, grade, cross-section, and density for at least 1000 feet (300 m) in advance of base laying operations. Unless specified otherwise, uniformly compact the foundation to not less than the density for standard compaction of the particular material existing in the foundation. Maintain the prepared foundation ahead of the base laying operations in a smooth condition and at not less than specified density. Remove any ruts or surface irregularities produced by hauling or other equipment or other traffic. Correct all soft or yielding areas, holes, or other defects that occur due to traffic, hauling, poor drainage, unstable materials, or from any other cause before placing the base. Remove snow or ice, if any, from the foundation before placing the base.

- (2) Bring the foundation for open graded base to the required grade and cross-section by means of a machine designed specifically for trimming foundations. The machine shall utilize automatic sensors to trim to the required grade and cross-section. If trimmed material consists of crushed aggregate, salvage and use this material in the aggregate base for shoulder construction.

211.3.4 Foundation for Concrete Pavement and Concrete Base

211.3.4.1 General

- (1) Prepare the foundation for concrete pavement or concrete base by restoring, preparing, and conditioning of unstabilized bases according to the requirements below for application by form or slip form methods.
- (2) For areas of the foundation that are impractical to prepare by machine methods, prepare these areas by hand methods satisfactory to the engineer.
- (3) Ensure that the foundation in all cases is in a moist but not saturated condition during concrete placement. Saturate the foundation with water, if required, not less than 6 hours before placing the concrete. If the foundation subsequently dries, moisten it by sprinkling water just before placing the concrete. Sprinkle the water to avoid forming pools.
- (4) Trim and shape the foundation for a concrete base or pavement for a width equal to the width of the intended base or pavement plus at least one foot (300 mm) on each side to approximately the required lines, grade, and cross-section; and then uniformly compact to the required density. Perform compaction with suitable rolling or other types of consolidating equipment. Unless specified otherwise, uniformly compact the foundation to not less than the density for standard compaction of earth subgrade, subbase, or base.
- (5) Complete preparing the foundation for at least 300 feet (90 m) in advance of depositing concrete, unless the engineer allows otherwise.
- (6) Trim and smooth ruts and irregularities in the foundation surface caused by trucks or other equipment hauling aggregates. Compact these ruts and irregularities ahead of concrete placing operations. Excavate, fill with suitable material, and compact soft and yielding spots.

211.3.4.2 Slip-Form Methods

- (1) If using slip-form methods, after satisfactorily compacting the base, bring the areas that will support the slip-form paver to the required grade by using a machine designed for that purpose. Bring areas where pavement will be placed to the required grade and cross-section by using a machine designed specifically for trimming foundations. The machine shall utilize automatic sensors to trim to the required grade and cross-section. If placing overlays on existing pavements, bring the areas of the shoulder that supported the slip-form paver to grade and satisfactorily compact by similar means. Test these areas for compliance with the required grades and cross-section. Perform these tests using methods, procedures, and equipment the engineer approves.

211.3.4.3 Form Methods

- (1) After preparing the foundation as specified above, set the forms according to the requirements specified for this work. Bring the foundation to true section and elevation using a subgrade trimming machine, mounted on wheels or rollers that ride on the forms, has sufficient weight, and adjustable cutting parts to provide the required section and elevation. Fill all depressions with suitable material, and remove excess material immediately after cutting. Dispose of excess material beyond the forms in a manner that does not interfere with concrete placing and finishing operations. After trimming, repeat rolling the foundation, and keep the foundation smooth and at the specified density until concrete placement.
- (2) If the engineer allows hauling or other equipment on the prepared foundation, operate a subgrade planer mounted on wheels or rollers riding on the forms ahead of the concrete being deposited, or restore the foundation, as necessary, by methods and equipment the engineer approves.

211.3.5 Foundation for Asphaltic Surfacing

211.3.5.1 General

- (1) Prepare the foundation for asphaltic surfacing by restoring, preparing, and conditioning of aggregate bases, existing asphaltic pavement or surfacing, or concrete bases and pavements, in the manner specified below, for applying an asphaltic treatment or surface.

- (2) Prepare the foundation sufficiently ahead of the prime coat or surfacing operations to allow uninterrupted progress of these operations. Prepare the aggregate base completely before applying the prime coat. Before applying the prime coat or asphaltic surfacing, clean the surface of the prepared foundation by brooming off all dust, dirt, debris, or other foreign or loose material.
- (3) For existing pavements where the drop-off at the edge of pavement is 2 inches (50 mm) or more, place shoulder material or bring the existing shoulder material flush with the pavement surface before placing asphaltic base, wedge, binder, or surface course.
- (4) Prepare the foundation for asphaltic shoulders by excavating, shaping, and preparing the existing crushed aggregate shoulder before and after constructing new shoulders. Use the excavated material to shape the remaining aggregate shoulders or to widen the roadbed where possible.

211.3.5.2 Aggregate Base

- (1) Scarify, shape, trim, and compact, where and as necessary, the surface of the aggregate base to produce the required cross-sectional contour; a profile free from abrupt changes in elevation; and a surface without pits, hollows, depressions, or projections.
- (2) Perform shaping and trimming with long-wheel-base motor graders or subgrade finishers designed for the purpose.

211.3.5.3 Asphaltic Treated Surfaces and Pavements

- (1) Remove areas that will cause raveling, shoving, or bleeding of the overlying pavement. If the engineer directs, remove other areas the engineer deems unsuitable. Remove protruding joint filler from cracks to at least the surface of the old pavement and remove excess joint filler and joint sealant materials from the pavement surface.
- (2) Clean all loose material from holes in the existing asphaltic pavement or surfacing. Fill the holes with asphaltic surface mixture and consolidate the mixture over its full depth.

211.3.5.4 Concrete Pavements and Bases

- (1) Remove all surplus crack and joint sealing material from the pavement surface. Remove all protruding joint materials, including fillers and sealers, from joints and cracks to at least the surface of the old concrete.
- (2) Completely remove unstable patches of asphaltic surface used to fill localized pits, depressions, or badly spalled, or disintegrated areas of the old pavement to the underlying concrete. Remove loose concrete or concrete with developing spalling within or adjacent to these areas.

211.3.6 Incorporating or Disposing of Surplus or Unsuitable Material

- (1) Dispose of all surplus or unsuitable material as specified in [205.3.12](#). The contractor may use aggregates with suitable engineering properties for building shoulders. The contractor may process and incorporate material resulting from removing old asphaltic pavement or surfacing in aggregate base or shoulders as allowed under [section 305](#), or if the contract designates this material for salvage, under [section 306](#).

211.3.7 Other Work

- (1) Perform other preparatory work the plans show, the contract requires, or as the engineer directs. This preparatory work may consist of removing and replacing base or subbase material; correcting the subgrade; removing existing asphaltic surface courses, curbs, gutters, or lip curbs; widening or patching base or existing pavement; furnishing and placing additional base; and similar work or operations.
- (2) If the engineer revises the profile grade, beyond the minor adjustments designated in [211.3.1](#), at the time of preparing the foundation for the construction of a base or surface course, perform the work as revised.

211.4 Measurement

- (1) The department will only measure work under the Prepare Foundation bid items within the limits the plan designates. Work outside the limits the plan designates is incidental to the contract.
- (2) The department will measure the lump sum Prepare Foundation bid items under this section as a single lump sum unit for each foundation acceptably completed.
- (3) The department will measure Prepare Foundation for Asphaltic Shoulders by the station, measured along each side of the traveled way.

- (4) The department will measure Prepare Foundation for Base Aggregate by the station, measured along the centerline or reference line of each roadway.

211.5 Payment

211.5.1 General

- (1) The department will pay for measured quantities at the contract unit prices under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
211.0100	Prepare Foundation for Asphaltic Paving (project)	LS
211.0200	Prepare Foundation for Concrete Pavement (project)	LS
211.0300	Prepare Foundation for Concrete Base (project)	LS
211.0400	Prepare Foundation for Asphaltic Shoulders	STA
211.0500	Prepare Foundation for Base Aggregate	STA

- (2) Payment is full compensation for the work required under this section, within the limits the plan designates for the Prepare Foundation bid items, except as specified otherwise here in 211.5. Required work performed outside the limits the plan designates for the Prepare Foundation bid items is incidental to the contract. If the contract does not contain a specific Prepare Foundation bid item, the work required under this section is incidental to the contract.
- (3) Payment also includes water for compaction and dust control except, if the contract contains the Water bid item, the department will pay separately for compaction and dust control water under [624.5](#).
- (4) The department will pay separately for the following work under the pertinent contract bid items, or absent the pertinent items, as extra work:
- Excavating and backfilling areas of yielding or unstable materials.
 - Performing engineer-ordered alterations of work previously completed.
 - Patching base or furnishing asphaltic surface mixtures for repair of asphaltic treated foundations.
 - Furnishing and placing required filling from beyond the roadbed limits to restore or adjust to required elevation a foundation constructed under a previous contract.

211.5.2 Other Work

- (1) The department will pay separately for the preparatory work required in [211.3.7\(1\)](#) under the pertinent contract bid items, or absent the pertinent items, as extra work.
- (2) The department will pay for the additional work required in [211.3.7\(2\)](#) at the contract unit prices, subject to provisions for increased or decreased quantities under [104.2.2.4](#), for the pertinent bid items, or absent the pertinent items, as extra work.

SECTION 213 FINISHING ROADWAY

213.1 Description

- (1) This section describes destroying noxious weeds, cleaning out drainage structures installed under the contract, cleaning out material deposited in existing structures as a result of construction operations, removing and disposing of all litter and debris, and final trimming and dressing required to neatly and satisfactorily restore and complete the entire roadway for any project or portion of a project where grading and drainage or structures are a part of the contract.
- (2) This section also describes destroying noxious weeds; removing and disposing of all litter and debris; and the final shaping, finishing, trimming and dressing of shoulders, shoulder slopes and all other portions of the roadway disturbed by contractor operations, on contracts for constructing base, or surface course, on any project or portions of a project where grading and roadway construction was or will be substantially completed under other contracts.

213.2 (Vacant)

213.3 Construction

- (1) On contracts where seeding was completed under a previous contract, the contractor is responsible for all damage caused by its operations to the seeded areas or the vegetative covering within the right-of-way. Replace topsoil that was lost or contaminated with other materials, and reseed or restore all areas damaged by the contractor's operations.
- (1) Trim, shape, and restore the shoulders to the finished cross-section by means of grader and other equipment, supplemented by hand work, if necessary, to produce smooth surfaces and slopes and uniform cross-sections. For graded roadbed without surfacing, trim and dress the entire roadbed in the same manner.
- (2) Remove loose and waste stones not used in construction that fail to pass a 3 inch (75 mm) ring from the roadway and ground surface within all areas of the clearing and grubbing limits.
- (3) In urban or other areas that require a lawn-type turf, remove all loose or waste stones that fail to pass a one-inch (25.0 mm) sieve from topsoiled areas.
- (4) Do not drag, push, or scrape material across or along the finished pavement or surface course.
- (5) During the life of the contract, destroy all noxious weeds within the limits of the right-of-way by cutting or by other means and prevent the weed plants from maturing to the bloom or flower stage. The term "noxious weeds" as defined here consists of Canada thistle, leafy spurge, field bindweed, and other weeds that the governing body of the county or municipality where the project is located declares noxious, according to section 66.96, Noxious Weeds, of the Wisconsin Statutes.
- (6) Before requesting acceptance of the work, if grading or structures are a part of the contract, clean out all soil, silt, or debris, and fully restore the waterways of all drainage installations and structures constructed under the contract. Remove all materials deposited or lodged in the waterways of all other drainage installations or structures due to contractor's operations.
- (7) Trim and dress the slopes of the roadway embankments and excavations to restore them to the established or specified lines and grades. Clear ditches and channels of debris and obstructions, and trim slopes and beds to true line and grade. Remove, shape, trim, and leave in a neat condition excess earth, debris, spoil banks, or other waste material next to culverts, bridges, ditches, channels, poles, posts, trees, or other objects. Remove stones, roots, or other waste materials exposed on embankment or excavation slopes that may become loosened and dislodged. Dispose of all slash and debris from clearing and grubbing operations, and leave the entire roadway in a neat condition. Fill holes and depressions that appear on the surface within the grubbing limits, caused by grubbing operations, with suitable material.

213.4 Measurement

- (1) The department will measure one Finishing Roadway for each contract acceptably completed.

213.5 Payment

- (1) The department will pay for measured quantities at the contract unit prices under the following bid item:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
213.0100	Finishing Roadway (project)	EACH

- (2) Payment for the Finishing Roadway bid items is full compensation for the work under this section. Payment includes restoring areas, seeded under a previous contract, damaged by the contractor's operations.
- (3) The department will pay separately for additional material from excavation required and furnished incidental to the repair of washouts under pertinent contract bid items or as extra work.
- (4) If the contract does not include a separate bid item for Finishing Roadway, then work under this section is incidental to the grading, subbase, base, structures, or surface course bid items.

SECTION 214 OBLITERATING OLD ROAD

214.1 Description

- (1) This section describes grading portions of the old road required to be abandoned, and includes scarifying or plowing areas of the old roadway. The work under this section applies only to those portions of the old roadway, designated for obliteration, located outside the slope limits of the grading for the new roadway.

214.2 (Vacant)

214.3 Construction

- (1) Grade and trim areas of the old roadway contiguous to and lying partly within the lateral grading limits of the new construction as required, to obliterate the old roadway.
- (2) Clear and grub areas outside the clearing and grubbing limits of the new project, necessary to properly obliterate the old road. Remove and dispose of or salvage miscellaneous structures from within the limits designated for obliteration. Topsoil, fertilize, and seed the area within the limits designated for obliteration.
- (3) After the road is no longer needed for traffic, fill the old ditches and grade the roadway, either to approximately restore the original contour of the ground or to produce a contour that merges with the contour of the adjoining land. If possible, place waste material from the new construction in cuts on the old road. If the engineer allows, in writing, the contractor may obtain borrow or select borrow required for the new construction from fills on the old road.
- (4) Break-down and bury, or remove old bridges and culverts to be removed, for which no separate provision for disposal is included in the contract, as specified for their removal under [section 203](#), except, leave no parts of the structures within 2 feet (0.6 m) of the finished surface.
- (5) Break all pavements, curb, gutter, and similar rigid structures, that have no separate provision for disposal in the contract, and that occur within 2 feet (0.6 m) of the proposed finished surface into pieces no larger than one square foot (0.1 m²) before covering. Break down and remove pavements, curb, gutter, and similar rigid structures if occurring within one foot (300 mm) of the proposed finished surface as specified for removing or abandoning miscellaneous structures under [section 204](#).
- (6) Scarify or plow old road surfacing of gravel, crushed stone, or other non-rigid types that have no separate provision of salvage or disposal included in the contract, and if underlying the proposed finished surface by less than one foot (300 mm) to effectively mix the material with soil. If possible, blade the surfacing material into the old ditches and cover with suitable soil.
- (7) Remove rocks, boulders, and surface stone encountered in the work and dispose of as specified for roadway and drainage excavation under [section 205](#). Place all stones larger than 6 inches (150 mm) at least 6 inches (150 mm) below the proposed finished surface. If the obliterated area is suitable for cultivation keep all stone to a reasonable minimum in the upper 18 inches (0.5 m) of completed embankment and place no structure or pavement concrete or other debris within 2 feet (0.6 m) of the finished grade.
- (8) After completing the rough grading, topsoil the areas of the obliterated old road designated on the plans, in the contract, or by the engineer as specified for placing topsoil in [section 625](#). After completing necessary topsoiling, harrow, smooth, fertilize, and seed the entire area of the obliterated old roadway as specified for fertilizer and seeding in [section 629](#) and [section 630](#), unless the engineer approves otherwise.
- (9) Remove material from culverts or bridges and other material, designated for salvage, to avoid damage, and place in neat piles on the right-of-way at locations the engineer designates.

214.4 Measurement

- (1) The department will measure Obliterating Old Road, by the 100-foot (40 m) station acceptably completed, measured along the old road centerline or reference line of those portions of the old roadway, designated for obliteration, located outside the slope limits of the grading for the new roadway. The department will exclude areas of the old road from which the contractor has obtained material under the Borrow or Select Borrow bid items.

214.5 Payment

- (1) The department will pay for measured quantities at the contract unit prices under the following bid item:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
214.0100	Obliterating Old Road	STA

- (2) Payment for Obliterating Old Road is full compensation for grading, scarifying, and plowing; for removing non-rigid pavement surfacing; and for all the other work required under this section except as follows:
1. The department will pay separately for clearing and grubbing under the Clearing and Grubbing bid items as specified in [201.5](#).
 2. The department will pay separately for grading and trimming areas of the old roadway contiguous to and lying partly within the lateral grading limits of the new construction under the Excavation bid items as specified in [205.5](#).
 3. The department will pay separately for borrow or select borrow required for the construction of the new roadway, if obtained from the old road, under the Borrow or Select Borrow bid items as specified in [208.5](#).
 4. The department will pay for asphaltic surfacing, gravel, crushed stone or other materials salvaged from the old road and used in the construction of the new road, as called for on the plans or ordered, separately.
 5. If the contract contains the Removing Pavement bid item, the department will pay separately for removing portland cement concrete pavement, brick pavement, and rigid base, from within the limits designated for obliteration, under the Removing Pavement bid item as specified in [204.5](#), or absent that bid item, as extra work.
 6. If the contract includes separate bid items for removing specific miscellaneous structures from within the limits designated for obliteration, the department will pay separately for these removals under the section 204 bid items specified under [204.5](#).
 7. The department will pay separately for removing old culverts and bridges under the section 203 bid items specified in [203.5](#).
 8. The department will pay for separately for topsoiling under the Topsoil or Salvaged Topsoil bid items as specified in [625.5](#).
 9. The department will pay separately for fertilizing under the Fertilizer bid items as specified in [629.5](#).
 10. The department will pay separately for seeding under the Seeding bid items as specified in [630.5](#).

PART 3 BASES AND SUBBASES

SECTION 301 GENERAL REQUIREMENTS FOR BASE AGGREGATES

301.1 Description

- (1) This section describes requirements common to aggregate bases constructed with crushed materials. Exceptions and additional requirements for crushed aggregate bases are specified in:
- [Section 305](#) for dense graded bases.
 - [Section 310](#) for open graded bases.

301.2 Materials

301.2.1 Definitions

- (1) Interpret these terms, used throughout part 3, as follows:

Aggregate	A composite mixture of hard, durable mineral materials that have been mechanically processed.
Virgin materials	Mineral materials in a native or raw form, not previously used.
Gravel	Naturally occurring rounded particles of rock that will be retained on a No. 10 (2.0 mm) sieve.
Sand	Granular material having at least 90 percent passing the No. 4 (4.75 mm) sieve and predominantly retained on the No. 200 (75 µm) sieve.
Crushed stone	Crushed angular particles of rock retained on a No. 10 (2.0 mm) sieve.
Fractured face	An angular, rough, or broken particle surface with sharp edges.
Reprocessed material	Waste material for which a commercially demonstrated process uses the material as a raw material.
Reclaimed asphaltic material	Crushed or processed asphaltic pavement or surfacing recovered from a contractor designated source.
Salvaged asphaltic material	Crushed or processed asphaltic pavement or surfacing recovered from a department designated source.
Breaker run	Aggregate resulting from the mechanical crushing of quarried stone or reclaimed concrete not screened or processed after primary crushing.
Pit run	Unprocessed aggregate, with predominately 1 1/2 inch or larger sized particles, obtained from a gravel pit.
Select crushed material	Crushed and screened aggregate with particles predominately larger than 1 1/2 inches.

301.2.2 Sampling and Testing

301.2.2.1 General

- (1) Unless the special provisions specify contractor testing, the department will sample and test aggregates as follows:

Sampling ^[1]	AASHTO T 2
Percent passing the 200 (75 µm) sieve ^[1]	AASHTO T 11
Gradation ^[1]	AASHTO T 27
Gradation of extracted aggregate	AASHTO T 30
Moisture content ^[1]	AASHTO T 255
Liquid limit.....	AASHTO T 89
Plasticity index	AASHTO T 90
Wear	AASHTO T 96
Sodium sulfate soundness ^[2]	AASHTO T 104
Freeze/thaw soundness.....	AASHTO T 103
Deleterious Materials ^[3]	AASHTO T 113 and CMM 13.22
Fracture	CMM 13.9
Moisture/density ^[1]	AASHTO T 99
In-place density ^[1]	AASHTO T 191
Asphaltic material extraction.....	CMM 13.19.10 WisDOT Test Method 1560

^[1] As modified in CMM 13.

^[2] The department will test aggregate retained on the No. 4 (4.75 mm) sieve using 5 cycles of the sodium sulfate soundness test.

^[3] The department will use these, and any other tests the engineer deems appropriate, to determine the acceptability of aggregates that, by the engineer's visual inspection, have excessive deleterious material.

- (2) Contact the engineer to collect sample aggregates proposed for the project. The engineer will obtain the sample, or observe the contractor obtaining the sample. The sampler must be HTCP certified to sample aggregates. Do not place base until the engineer tests and approves the material, except as allowed in [106.1](#).

301.2.2.2 Freeze-Thaw Soundness Testing

- (1) The department will conduct freeze/thaw soundness tests, on the fraction retained on the No. 4 (4.75 mm) sieve, for virgin crushed stone aggregates produced from limestone/dolomite sources in one or more of the following counties or from out of state:

Brown	Columbia	Crawford	Dane	Dodge
Fond du Lac	Grant	Green	Green Lake	Iowa
Jefferson	Lafayette	Marinette	Oconto	Outagamie
Rock	Shawano	Walworth	Winnebago	

- (2) The department may waive freeze/thaw testing for existing quarries determined to be in either the Silurian system or the Prairie du Chien group of the Ordovician system of rocks.

301.2.3 Aggregate Requirements

301.2.3.1 General

- (1) Furnish aggregates that are substantially free of deleterious materials.
- (2) The department may prohibit the use of crushed stone from limestone/dolomite deposits that have thinly bedded strata or strata of a shale nature. The department may also prohibit the use of aggregate from deposits or sources known to produce unacceptable material.

301.2.3.2 Aggregate Classifications

- (1) Provide aggregate conforming to one of the following classifications based on weight percentages.

Crushed stone or crushed gravel ≥ 85 percent virgin aggregates

Crushed concrete ≥ 90 percent crushed concrete that is free of steel reinforcement and includes < 10 percent asphaltic pavement or surfacing, base, or a combination of asphaltic pavement, surfacing, and base, incorporated during the removal operation.

Reclaimed asphaltic pavement ≥ 75 percent asphaltic pavement or surfacing.

Reprocessed material Consists of crushed concrete, reclaimed asphaltic pavement, crushed stone or gravel, or other construction materials that is thoroughly mixed and conforms to the following:

1. ≥ 80 percent is a combination of crushed concrete and asphaltic pavement or surfacing; where:
 - < 90 percent is crushed concrete, or else the material is classified as crushed concrete.
 - < 75 percent is reclaimed asphaltic pavement, or else the material is classified as reclaimed asphaltic pavement.
2. < 20 percent is crushed stone or gravel, concrete block, brick, cinder, or slag particles; where:
 - < 10 percent of the final mixture is concrete block particles.
 - < 5 percent of the final mixture is brick, cinder, or slag particles.

Blended material A blend of crushed stone, crushed gravel, crushed concrete, reclaimed asphaltic pavement, or reprocessed material thoroughly mixed and meeting the following:

1. Each individual component material, incorporated into the blend must meet the requirements of table 301-2 except for gradation. The final blend must conform to the specified gradation.
2. < 75 percent is reclaimed asphaltic pavement, or else the material is classified as reclaimed asphaltic pavement
3. < 90 percent is crushed concrete, or else the material is classified as crushed concrete.

4. < 80 percent is a combination of crushed concrete and asphaltic pavement or surfacing, or else the material is classified as reprocessed material.
5. < 85 percent is crushed stone or gravel, or else the material is classified as virgin aggregate.

301.2.3.3 Uses For Aggregate Classifications

- (1) The contractor may furnish the aggregate classifications, at the contractor's option, for the specified base types as allowed in table 301-1.

TABLE 301-1 USES FOR VARIOUS AGGREGATE BASE CLASSIFICATIONS

BASE TYPE	CRUSHED STONE and CRUSHED GRAVEL	CRUSHED CONCRETE	RECLAIMED ASPHALTIC PAVEMENT	REPROCESSED MATERIAL	BLENDED MATERIAL
Dense 3/4-inch	Yes	Yes	No	Yes ^[1]	Yes ^[1]
Dense 1 1/4-inch	Yes	Yes	Yes	Yes	Yes
Dense 3-inch	Yes	Yes	Yes	Yes	Yes
Open graded	Yes	Yes	No	No	No

^[1] The contractor may provide reprocessed material or blended material as 3/4-inch base only if the material contains 50 percent or less reclaimed asphaltic pavement, by weight.

301.2.3.4 By-Product Materials

- (1) The contractor may provide an aggregate with one of the following by-product materials mixed with crushed gravel, crushed concrete, or crushed stone up to the listed maximum percentage, by weight.

BY-PRODUCT MATERIAL	MAXIMUM PERCENTAGE (by weight)
Glass	12
Foundry slag	7
Steel mill slag	15
Bottom ash	8
Pottery cull	7

- (2) Furnish by-product materials substantially free of deleterious substances.
- (3) Crush, screen, and combine materials to create a uniform mixture conforming to the predominant material specifications.
- (4) If the aggregate contains a by-product material, the department will test the final product for gradation, wear, soundness, liquid limit, plasticity, and fracture as required for the predominant material.
- (5) Do not use aggregate containing a by-product material in the top 3 inches of a temporary or permanent aggregate wearing surface.

301.2.3.5 Aggregate Base Physical Properties

- (1) Furnish aggregates conforming to the following:

TABLE 301-2 AGGREGATE BASE PHYSICAL PROPERTIES

PROPERTY	CRUSHED STONE and CRUSHED GRAVEL	CRUSHED CONCRETE	RECLAIMED ASPHALTIC PAVEMENT	REPROCESSED MATERIAL	BLENDED MATERIAL
Gradation AASHTO T 27 dense open	305.2.2.1 310.2	305.2.2.1 310.2	305.2.2.2 ----	305.2.2.1 ----	305.2.2.1 ^[1] ----
Wear AASHTO T 96 loss by weight	≤50%	note ^[2]	----	note ^[2]	note ^[3]
Sodium sulfate soundness AASHTO T 104 loss by weight dense open	≤18% ≤12%	---- ----	---- ----	---- ----	note ^[3] note ^[3]
Freeze/thaw soundness AASHTO T 103 loss by weight dense open	≤18% ≤18%	---- ----	---- ----	---- ----	note ^[3] note ^[3]
Liquid limit AASHTO T 89	≤25	≤25	----	----	note ^[3]
Plasticity AASHTO T 90	≤6 ^[4]	≤6 ^[4]	----	----	note ^[3]
Fracture CMM 13.9 min one face by count dense open	58% 90%	58% 90%	---- ----	note ^[5] ----	note ^[3] ----

^[1] The final aggregate blend must conform to the specified gradation.

^[2] No requirement for material taken from within the project limits. Maximum of 50 percent loss, by weight, for material supplied from a source outside the project limits.

^[3] Required as specified for the individual component materials defined in columns 2 - 5 of the table before blending.

^[4] For base placed between old and new pavements, use crushed stone, crushed gravel, or crushed concrete with a plasticity index of 3 or less.

^[5] ≥75 percent by count of non-asphalt coated particles.

301.3 Construction

301.3.1 Equipment

- (1) Use specialized pneumatic or vibratory compaction equipment or a combination of both types of machines. Do not use tamping rollers. Use pneumatic compaction equipment conforming to [207.3.6.2](#). The engineer may allow the contractor to compact the shoulder foreslopes with other equipment.

301.3.2 Preparing the Foundation

- (1) Prepare the foundation, or resurface the previously placed base layer, as specified in [section 211](#) before placing base. Do not place base foundations that are soft, spongy, or covered by ice or snow. Water and rework or re-compact dry foundations as necessary to ensure proper compaction, or as the engineer directs.

301.3.3 Stockpiling

- (1) If continuous compliance with material specifications is questionable, the engineer may require the contractor to supply material from a stockpile of previously tested material. Maintain a sufficiently large stockpile to preclude the use of material not previously approved.
- (2) Build and maintain stockpiles using methods that minimize segregation and prevent contamination. If the contract specifies location, place stockpiles where specified. Clear and prepare stockpile areas to facilitate the recovery of the maximum amount of stockpiled material.

301.3.4 Constructing Base

301.3.4.1 General

- (1) Place aggregate in a manner that minimizes hauling on the subgrade. Do not use vehicles or operations that damage the subgrade or in-place base. Deposit material in a manner that minimizes segregation.
- (2) Construct the base to the width and section the plans show. Shape, and compact the base surface to within 0.04 feet (12 mm) of the plan elevation.
- (3) Ensure there is adequate moisture in the aggregate during placing, shaping, and compacting to prevent segregation and achieve adequate compaction.
- (4) Maintain the base until paving over it, or until the engineer accepts the work, if paving is not part of the contract. The contractor is not responsible for maintaining material placed on detours, unless the special provisions specify otherwise.

301.3.4.2 Standard Compaction

- (1) Compact the base until there is no appreciable displacement, either laterally or longitudinally, under the compaction equipment. Route hauling equipment uniformly over previously placed base. Compact each layer before placing a subsequent layer. If the material is too dry to readily attain the required compaction, add water as necessary to achieve compaction.

301.3.4.3 Special Compaction

- (1) If the contract requires special compaction, compact each layer to 95 percent of maximum density, or more, before placing the subsequent layer. The engineer will determine the maximum density according to AASHTO T 99 method C or D and in-place density according to AASHTO T 191.

301.3.5 Excavation Below Subgrade

- (1) The engineer may request EBS in areas of placed base. Restore the surface in EBS areas to the plan grade and cross section or as the engineer directs.

301.3.6 Controlling Dust

- (1) Apply water or other engineer-approved dust control materials to control dust during construction and maintenance of the base and shoulders.

301.4 Measurement

301.4.1 General

- (1) For aggregate measured by the ton, the department will determine the weight based on contractor-provided tickets. Give the engineer a ticket, for each load delivered to the project, showing the net weight of the load, the type of material, the date, and project number.
- (2) For weighed aggregate delivered with a moisture content greater than 7 percent, the department will reduce the ticket weight by the weight of water exceeding 7 percent. The department will determine the aggregate moisture content based on and expressed as a percent of the aggregate dry weight.
- (3) For aggregate measured by the cubic yard, the department will determine the volume in the vehicle.

301.4.2 Alternate Measurement Procedures

- (1) The department may convert the measurement method from weight to volume or volume to weight as specified in [109.1](#). The engineer may adjust the conversion factor daily or with changing conditions, such as moisture content, as specified in [301.4.1](#).

301.5 Payment

- (1) The department will only pay for engineer-approved EBS to correct problems beyond the contractor's control. Work performed under [105.3](#) to correct unacceptable work is the contractor's responsibility. For EBS performed after placing subbase or base in the EBS area, the department will pay for EBS as follows:
 - 1. For excavation, the department will pay 3 times the contract unit price for the Excavation Common bid item under the EBS Post Placing Subbase or EBS Post Placing Base administrative item.
 - 2. For backfill and restoration with the materials the engineer directs, the department will pay 3 times the contract unit price for the bid items of each material used to fill the excavation and restore the subbase or base under the Restoration Post Completion administrative item.
 - 3. For excavation, backfill, or restoration work without contract bid items, as extra work.
- (2) Payment also includes water for compaction and dust control except, if the contract contains the Water bid item, the department will pay separately for compaction and dust control water under [624.5](#).

SECTION 305 DENSE GRADED BASE

305.1 Description

- (1) This section describes constructing a dense graded base using one of the following aggregates at the contractor's option:

Crushed stone	Reclaimed asphaltic pavement
Crushed gravel	Reprocessed material
Crushed concrete	Blended material

305.2 Materials

305.2.1 General

- (1) Provide aggregate conforming to [301.2](#) for crushed stone, crushed gravel, crushed concrete, reclaimed asphaltic pavement, reprocessed material, or blended material.

305.2.2 Gradations

305.2.2.1 General

- (1) Except for reclaimed asphaltic pavement, conform to the following gradation requirements:

SIEVE SIZE	PERCENT PASSING BY WEIGHT		
	3-INCH (75 mm)	1 1/4-INCH (31.5 mm)	3/4-INCH (19.0 mm)
3 inch (75 mm)	90 - 100	—	—
1 1/2 inch (37.5 mm)	60 - 85	—	—
1 1/4 inch (31.5 mm)	—	95 - 100	—
1 inch (25.0 mm)	—	—	100
3/4 inch (19.0 mm)	40 - 65	70 - 93	95 - 100
3/8 inch (9.5 mm)	—	45 - 80	50 - 90
No. 4 (4.75 mm)	15 - 40	30 - 63	35 - 70
No. 10 (2.00 mm)	10 - 30	20 - 48	15 - 55
No. 40 (425 µm)	5 - 20	8 - 28	10 - 35
No. 200 (75 µm)	2.0 - 12.0	2.0 - 12.0 ^{[1][3]}	5.0 - 15.0 ^[2]

^[1] Limited to a maximum of 8.0 percent for base placed between old and new pavement.

^[2] 8.0 - 15.0 percent if base is ≥ 50 percent crushed gravel.

^[3] 4.0 - 10.0 percent if base is ≥ 50 percent crushed gravel

- (2) Unless the plans or special provisions specify otherwise, do the following:

1. Use 1 1/4-inch (31.5 mm) base in top 4 or more inches (75 mm) of base. Use 3-inch (75 mm) base or 1 1/4-inch (31.5 mm) base in the lower base layers.
2. Use 3/4-inch (19.0 mm) base in the top 3 inches (75 mm) of the unpaved portion of the shoulder. Also, if using 3-inch (75 mm) base in the lower base layers, use 3/4-inch (19.0 mm) base in the top 3 inches (75 mm) of the shoulder foreslopes. Use 3/4-inch (19.0 mm) base or 1 1/4-inch (31.5 mm) base elsewhere in shoulders.

305.2.2.2 Reclaimed Asphaltic Pavement

- (1) For reclaimed asphaltic pavement, furnish material conforming to the following:
- 100 percent passing a 1 1/4-inch (31.5 mm) sieve.
 - 75 percent or less of the aggregate passing a No. 4 (4.75 mm) sieve.
 - Asphalt content between 3 percent and 6.5 percent inclusive.
- (2) The department will assess these properties primarily by visual inspection but may test questionable material. If testing the material, the department will determine the properties as follows:
- For the percent passing the 1 1/4 inch (31.5 mm) sieve, the department will test without conducting an asphaltic material extraction.
 - For the percent passing the No. 4 (4.75 mm) sieve and percent of asphalt content, the department will test by conducting an asphaltic material extraction as specified in [301.2.2.1](#).
- (3) The contractor may use reclaimed asphaltic pavement as 3-inch base, or 1 1/4-inch base without regard to the gradation requirements under 305.2.2.1.

305.3 Construction

305.3.1 General

- (1) Construct dense graded base conforming to [301.3](#).

305.3.2 Compaction

305.3.2.1 General

- (1) Compact each base layer, including shoulder foreslopes, with equipment specified in [301.3.1](#). Use standard compaction conforming to [301.3.4.2](#), unless the special provisions specify other methods. Final shaping of shoulder foreslopes does not require compaction.

305.3.2.2 Compacting 1 1/4-Inch Base and 3/4-Inch Base

- (1) If using a pneumatic roller, do not exceed a compacted thickness of 6 inches (150 mm) per layer. For the first layer placed over a loose sandy subgrade, the contractor may, with the engineer's approval, increase the compacted layer thickness to 8 inches (200 mm).
- (2) If using a vibratory roller, do not exceed a compacted thickness of 8 inches (200 mm) per layer.

305.3.2.3 Compacting 3-Inch Base

- (1) Compact with a vibratory or pneumatic roller. Do not exceed a compacted thickness of 9 inches (225 mm) per layer.

305.3.3 Constructing Aggregate Shoulders

305.3.3.1 General

- (1) Construct aggregate shoulders to the elevations and typical sections the plans show, except for minor modifications needed to conform to other work.
- (2) Use equipment that does not damage or mar the pavement surface, curbs, or appurtenances.
- (3) Place aggregate directly on the shoulder area between the pavement edge and the outer shoulder limits. Recover uncontaminated material deposited outside the limits and place within the limits.
- (4) Do not deposit aggregate on the pavement during placement, unless the engineer specifically allows. Do not leave aggregate on the pavement overnight. After placing the shoulder aggregate, keep the pavement surface free of loose aggregate.
- (5) Spread and compact the aggregate in compacted layers of 6 inches (150 mm) or less. Use standard compaction conforming to [301.3.4.2](#), unless the special provisions specify otherwise.
- (6) After final compaction, shape the shoulders to remove all longitudinal ridges to ensure proper drainage.

305.3.3.2 Shoulders Adjacent to Concrete Pavement or Base

- (1) Construct shoulders along concrete pavement or concrete base so the completed shoulder is at the approximate grade and cross-section before opening the pavement to public traffic.

305.3.3.3 Shoulders Adjacent to Asphaltic Pavement or Surfacing

- (1) If the roadway is closed to through traffic during construction, construct the aggregate shoulders before opening the road.
- (2) If the roadway remains open to through traffic during construction and a 2-inch (50 mm) or more drop-off at the pavement edge exists, eliminate the drop-off within 48 hours after completing the asphalt work. Unless the special provisions specify otherwise, provide aggregate shoulder material compacted to a 4:1 or flatter cross slope from the surface of the pavement edge.
- (3) Provide and maintain signing and other traffic protection and control devices, as specified in [section 643](#), until completing shoulder construction to the required cross-section and flush with the asphaltic pavement or surfacing.

305.3.4 Shaping Shoulders

- (1) Under the Shaping Shoulders bid item, blade, shape and compact the existing shoulder aggregate, before the end of the day's work, to ensure proper drainage while salvaging existing pavement and constructing new pavement. Do not contaminate the shoulder aggregate with deleterious material. Incorporate material obtained from shaping shoulders in the new shoulder, in widening the roadbed, or as the plans show.

305.3.5 Constructing Detours

- (1) Under the Aggregate Detours bid item, provide aggregate on the designated detour at the locations the plans show or the engineer directs. Use 3/4-inch (19.0 mm) base unless the plans or special provisions specify otherwise.

305.4 Measurement

- (1) The department will determine weight or volume, adjust for moisture, and convert between weight and volume as specified in [301.4](#). The department may deduct for contaminated aggregate or unrecovered aggregate deposited outside the outer shoulder limits.
- (2) The department will measure the Base Aggregate Dense and Aggregate Detours bid items under this section by the ton or cubic yard acceptably completed.
- (3) The department will measure Shaping Shoulders by the station acceptably completed, measured along the centerline for each shoulder separately.

305.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
305.0110	Base Aggregate Dense 3/4-Inch	TON
305.0115	Base Aggregate Dense 3/4-Inch	CY
305.0120	Base Aggregate Dense 1 1/4-Inch	TON
305.0125	Base Aggregate Dense 1 1/4-Inch	CY
305.0130	Base Aggregate Dense 3-Inch	TON
305.0135	Base Aggregate Dense 3-Inch	CY
305.0410	Aggregate Detours	TON
305.0415	Aggregate Detours	CY
305.0500	Shaping Shoulders	STA

- (2) Payment for the Base Aggregate Dense bid items is full compensation for preparing the foundation; and for stockpiling, placing, shaping, compacting, and maintaining the base.
- (3) Payment for Shaping Shoulders is full compensation for blading, shaping, compacting, and maintaining the existing aggregate shoulders.
- (4) For the bid items under this section except for Aggregate Detours, the department will pay for EBS in areas of placed base, dust control water, and compaction water as specified in [301.5](#).
- (5) Payment for Aggregate Detours is full compensation for preparing the foundation; and for stockpiling, placing, shaping, and compacting aggregate on detours. The department will pay for EBS in areas of placed base, and compaction water as specified in [301.5](#).
- (6) If the contractor uses 3-inch material in the lower base layer, as allowed under [305.2.2.1](#), and the special provisions do not require 3-inch material, the department will pay for that material at the contract unit price for Base Aggregate Dense 1 1/4-Inch.

SECTION 306 SALVAGED ASPHALTIC PAVEMENT BASE

306.1 Description

- (1) This section describes constructing a dense graded aggregate base, using department furnished material from one of the following sources:
 1. Recovered under the Salvaged Asphaltic Pavement bid items from existing asphaltic pavement or surfacing located within the project limits.
 2. Recovered asphaltic pavement from a source the special provisions specify.

306.2 Materials

- (1) Furnish material with 100 percent passing a 1 1/4-inch (31.5 mm) sieve. For shouldering applications, provide reprocessed material or blended material containing between 45 and 55 percent salvaged asphaltic pavement or surfacing, by weight.

306.3 Construction

- (1) Under the Salvaged Asphaltic Pavement Base bid items, process stockpiled material as necessary to conform to [306.2](#) and place material as the plans or special provisions specify. Construct the base conforming to [305.3](#).
- (2) Excess material recovered from within the project limits under the Salvaged Asphaltic Pavement bid items becomes the property of the contractor.

306.4 Measurement

- (1) The department will determine weight or volume, adjust for moisture, and convert between weight and volume as specified in [301.4](#). The department may deduct for contaminated aggregate or unrecovered aggregate deposited outside the outer shoulder limits.
- (2) The department will measure the Salvaged Asphaltic Pavement Base by the ton or cubic yard acceptably completed.

306.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
306.0110	Salvaged Asphaltic Pavement Base	TON
306.0115	Salvaged Asphaltic Pavement Base	CY

- (2) Payment for Salvaged Asphaltic Pavement Base is full compensation for processing to size; for preparing the foundation; and for placing, compacting, shaping, and maintaining the base. The department will pay for EBS in areas of placed base, and compaction water as specified in [301.5](#).

SECTION 310 OPEN GRADED BASE

310.1 Description

- (1) This section describes constructing open graded base, for overlaying with new pavement, using one or more of the following aggregates:
1. Crushed stone.
 2. Crushed gravel.
 3. Crushed concrete.

310.2 Materials

- (1) Furnish crushed stone, crushed gravel, or crushed concrete conforming to [301.2](#), except for gradation conform to the following:

SIEVE SIZE	PERCENT PASSING (by weight)
1 inch (25.0 mm)	90 - 100
3/8 inch (9.5 mm)	45 - 65
No. 4 (4.75 mm)	15 - 45
No. 10 (2.00 mm)	0 - 20
No. 40 (425 µm)	0 - 10
No. 200 (75 µm)	0 - 5.0

310.3 Construction

- (1) Construct open graded base conforming to [301.3](#).
- (2) Use standard compaction conforming to [301.3.4.2](#), unless the special provisions specify other methods.
- (3) Compact in layers using the equipment specified in [301.3.1](#). If using a pneumatic roller, do not exceed a compacted thickness of 6 inches (150 mm) per layer. If using a vibratory roller, do not exceed a compacted thickness of 8 inches (200 mm) per layer.

310.4 Measurement

- (1) The department will determine weight or volume, adjust for moisture, and convert between weight and volume as specified in [301.4](#).
- (2) The department will measure Base Aggregate Open Graded by the ton or cubic yard acceptably completed.

310.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
310.0110	Base Aggregate Open Graded	TON
310.0115	Base Aggregate Open Graded	CY

- (2) Payment for Base Aggregate Open Graded is full compensation for preparing the foundation; and for stockpiling, placing, shaping, compacting, and maintaining the base. The department will pay for EBS in areas of placed base, dust control water, and compaction water as specified in [301.5](#).

SECTION 311 BREAKER RUN

311.1 Description

- (1) This section describes providing breaker run.

311.2 Materials

- (1) Furnish stone or concrete processed through a primary crusher set to produce a material predominantly 6 inches (150 mm) or less in at least one dimension. Obtain material from an department-approved source substantially free of unconsolidated overburden materials, topsoil, organic materials, and other deleterious materials.
- (2) An department-approved source is any quarry with acceptable department test results for wear and soundness on record. The engineer may also approve other sources as follows:
1. Mined or quarried waste rock that, in the engineer's opinion, is hard, durable, and when processed through a primary crusher, will produce a material similar in size and texture to that produced from a quarry face.
 2. Concrete that the engineer judges substantially free of steel, building materials or other deleterious material; and when processed through a primary crusher, produces a material similar in size and texture to that produced from a quarry face.
 3. Material from a new or untested quarry that, in the engineer's opinion, is hard, durable, and comparable to that normally used to produce aggregate.
- (3) The engineer may reject material produced from deteriorated concrete or from non-durable rock such as sandstone, shale, slate, disintegrated granite, or heavily weathered rock of any type.
- (4) The department will assess breaker run acceptability based primarily on the engineer's visual inspection.

311.3 Construction

- (1) Place breaker run where the plans show or as the engineer directs.
- (2) Compact breaker run using standard compaction conforming to [301.3.4.2](#).

311.4 Measurement

- (1) The department will determine weight or volume, adjust for moisture, and convert between weight and volume as specified in [301.4](#).
- (2) The department will measure Breaker Run by the ton or cubic yard acceptably completed.

311.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
311.0110	Breaker Run	TON
311.0115	Breaker Run	CY

- (2) Payment for Breaker Run is full compensation for providing and compacting breaker run material, including substituting with 3-inch (75 mm) base as allowed in 311.3.
- (6) The department will pay for EBS in areas of placed base as specified in [301.5](#).

SECTION 312 SELECT CRUSHED MATERIAL

312.1 Description

- (1) This section describes providing select crushed material.

312.2 Materials

- (1) Furnish crushed rock or concrete from an department-approved source substantially free of unconsolidated overburden materials, topsoil, organic materials, and other deleterious materials.
- (2) An department-approved source is any source with acceptable department test results for wear and soundness on record. The engineer may also approve other sources as follows:
1. Mined or quarried waste rock that, in the engineer's opinion, is hard, durable, and when processed through a primary crusher, will produce a material similar in size and texture to that produced from a quarry face.
 2. Concrete that the engineer judges substantially free of steel, building materials or other deleterious material; and when processed through a primary crusher produces a material similar in size and texture to that produced from a quarry face.
 3. Material from a new or untested quarry or pit that the engineer judges hard, durable, and comparable to that normally used to produce aggregate.
- (3) The engineer may reject material produced from deteriorated concrete or from non-durable rock such as sandstone, shale, slate, disintegrated granite, or heavily weathered rock of any type.
- (4) Conform to the following gradation:

SIEVE SIZE	PERCENT PASSING (by weight)
5 inch (125 mm)	90 - 100
1 1/2 inch (37.5 mm)	20 - 50
No. 10 (2.00 mm)	0 - 10

- (5) Furnish a material that has a minimum of 50 percent, by count, of the number of particles retained on the 1 1/2 inch (37.5 mm) sieve with at least 2 fractured faces.
- (6) The department will assess select crushed material acceptability based primarily on the engineer's visual inspection. The department may also test for gradation or fracture.

312.3 Construction

- (1) Place select crushed material where the plans show or as the engineer directs.
- (2) Compact select crushed material using standard compaction conforming to [301.3.4.2](#).

312.4 Measurement

- (1) The department will determine weight or volume, adjust for moisture, and convert between weight and volume as specified in [301.4](#).
- (2) The department will measure Select Crushed Material by the ton or cubic yard acceptably completed.

312.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
312.0110	Select Crushed Material	TON
312.0115	Select Crushed Material	CY

- (2) Payment for Select Crushed Material is full compensation for providing and compacting select crushed material, including substituting 3-inch (75 mm) base as allowed in 312.3.
- (6) The department will pay for EBS in areas of placed base as specified in [301.5](#).

SECTION 313 PIT RUN

313.1 Description

- (1) This section describes providing pit run material.

313.2 Materials

- (1) Furnish a homogenous mixture of naturally occurring material that has at least 50 percent by weight retained on the 1 1/2 (37.5 mm) sieve, with the remaining material composed of sand that has nominal amounts of silt/clay. The maximum size of an individual piece cannot be more than 2/3 of the specified layer thickness. Obtain material from an department-approved source substantially free of topsoil, organic materials, and other deleterious materials.
- (2) An department-approved source is any pit with acceptable department test results for wear and soundness on record. The engineer may also approve other sources conforming to the following criteria.
1. The deposit, in the engineer's opinion, is of suitable texture and composition to produce crushed and graded aggregates.
 2. The material in the deposit is, in the engineer's opinion, sound, hard, and durable.
 3. Material from the pit that in the engineer's judgment, conforms to 313.2(1).
- (3) The engineer may reject material produced from any pit with excessive amounts of non-durable rock such as sandstone, shale, slate, disintegrated granite, or heavily weathered rock of any type.
- (4) The department will assess pit run acceptability based primarily on the engineer's visual inspection.

313.3 Construction

- (1) Place pit run where the plans show or as the engineer directs. The contractor may substitute 3-inch (75 mm) base material as specified in [305.2](#), breaker run as specified in [311.2](#), or select crushed material as specified in [312.2](#) for pit run material.
- (2) Compact pit run using standard compaction conforming to [301.3.4.2](#).

313.4 Measurement

- (1) The department will determine weight or volume, adjust for moisture, and convert between weight and volume as specified in [301.4](#).
- (2) The department will measure Pit Run by the ton or cubic yard acceptably completed.

313.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
313.0110	Pit Run	TON
313.0115	Pit Run	CY

- (2) Payment for Pit Run is full compensation for providing and compacting pit run material, including substituting with 3-inch (75 mm) base as allowed in 313.3.
- (3) The department will pay for EBS in areas of placed base as specified in [301.5](#).

SECTION 315 ASPHALTIC BASE

315.1 Description

- (1) This section describes constructing a plant mixed asphaltic base for overlaying with new pavement.

315.2 Materials

- (1) Furnish one-inch (25.0 mm) nominal size aggregate graded as specified in [460.2.2.3](#) and conform to the other material and mixture requirements specified for asphaltic surface in [section 465](#).

315.3 Construction

315.3.1 General

- (1) Conform to the general requirements for asphaltic pavements specified in [section 450](#), except as modified here in 315.3. Place the mixture in 4-inch (100 mm) or thinner compacted layers unless the engineer directs otherwise.

315.3.2 Asphaltic Base Widening

- (1) Excavate and widen the existing shoulder to accommodate the base widening. After placing the asphaltic base, reconstruct the shoulder and slope to the grade and cross-section the plans show. Unless the engineer directs otherwise, reconstruct using the previously excavated material. Dispose of unused material as specified in [205.3.12](#).
- (2) Prepare the foundation for the asphaltic base mixture as specified in [section 211](#). If the width of the base widening precludes using trench rollers and other conventional equipment, prepare and compact the foundation using engineer-approved hand methods.
- (3) Place the mixture to the thickness of the existing abutting pavement, including the existing asphaltic surfacing, unless the contract specifies otherwise. Construct in successive layers until the top surface is flush with the adjacent pavement surface. Before allowing the asphaltic mixture to cool; place, spread, strike off, and compact the material.
- (4) The engineer may allow other spreading and compacting methods and equipment if the width of the base widening precludes using the equipment specified in [section 450](#).

315.4 Measurement

- (1) The department will measure Asphaltic Base and Asphaltic Base Widening by the ton acceptably completed as specified for asphaltic pavement in [450.4](#).
- (2) The department will not measure asphaltic materials, required for and incorporated in the mixture, separately.

315.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
315.0100	Asphaltic Base	TON
315.0200	Asphaltic Base Widening	TON

- (2) Payment is full compensation for preparing the foundation; for providing an asphaltic base mixture design, when required; for providing and placing the mixture, including asphaltic material and any salvaged or reclaimed asphaltic pavement materials; and for compacting the mixture.
- (3) Payment for Asphaltic Base Widening also includes excavating, reconstructing earth shoulders, and disposing of surplus or unsuitable excavated material.

SECTION 320 CONCRETE BASE

320.1 Description

- (1) This section describes constructing a concrete base for overlaying with new pavement.

320.2 Materials

- (1) Furnish materials as specified for concrete pavement under [section 415](#) except use grade B, B-FA, B-S, B-IS, or B-IP concrete as specified in [section 501](#).

320.3 Construction

320.3.1 General

- (1) Construct as specified for concrete pavement under [section 415](#) except as modified here in 320.3.

320.3.1.1 Consolidating and Finishing

- (1) Consolidate and finish as specified for concrete pavement under [415.3.11](#), except the engineer will not require float finishing under [415.3.11.4](#), tining under [415.3.11.6](#), or surface testing and correction under [415.3.11.8](#).

320.3.1.2 Opening Concrete to Traffic

- (1) Conform to the procedures and opening criteria specified for grade A concrete used in concrete pavement under [415.3.17](#). If the contractor prevents loading within 6 inches (150 mm) of the edge:
 - 1. The engineer will allow the contractor to open to traffic when the concrete reaches 2000 pounds per square inch (13.8 MPa).
 - 2. In the absence of compressive strength information, the engineer may allow the contractor to open to traffic after 3 equivalent curing days expire.

320.3.1.3 Tolerance in Thickness

- (1) The engineer will not require the contractor to conform to the tolerance in pavement thickness provisions specified for concrete pavement under [415.3.18](#).

320.3.2 Concrete Base

320.3.2.1 General

- (1) Construct as a single layer on a prepared foundation to the thickness the plans show. Prepare the foundation as specified in [section 211](#).

320.3.2.2 Joints

- (1) Provide transverse joints as the plans show or the engineer directs.
- (2) Locate longitudinal joints as the plans show. If the plans do not show the joint locations, provide longitudinal joints on the centerline for 2-lane concrete base or at the edges of the traffic lanes parallel to the centerline of the roadway for multi-lane concrete base.
- (3) Construct longitudinal joints as the plans show. If the plans do not show construction details, install 1/2-inch diameter (15M) or larger tie bars, 24 inches (600 mm) long or longer, at 3 foot (900 mm) spacing.
- (4) Saw, form, or tool contraction joints as specified for transverse joints in concrete pavement under [415.3.9.2](#).

320.3.3 Concrete Base Widening

320.3.3.1 General

- (1) Construct concrete base adjacent to the existing pavement edges to widen the pavement to the total width of base and existing pavement the plans show. Provide the thickness the plans show.

320.3.3.2 Joints

- (1) Unless the plans show or the engineer directs otherwise, the department will not require ties to the existing pavement or joints within the widened area.

320.3.3.3 Excavation

- (1) Excavate and widen the existing shoulder. After placing the concrete, reconstruct the shoulder and slope to the grade and cross-section the plans show. Unless the engineer directs otherwise, reconstruct using the previously excavated material. Dispose of unused material as specified in [205.3.12](#).

320.3.3.4 Forms

- (1) The engineer will not require forms if the contractor excavates a trench of the required width and depth.

320.3.3.5 Preparing the Foundation

- (1) Prepare the foundation as specified in [section 211](#), except do not use rollers or subgrade machines. The contractor may compact and prepare the foundation by hand.

320.3.3.6 Depositing Concrete

- (1) Deposit concrete to require as little rehandling as possible and prevent contamination. Place and consolidate the concrete by hand or with engineer-approved machines. Strike off and finish flush with the adjoining pavement surface and sloping away from the existing pavement as the plans show.

320.4 Measurement

- (1) The department will measure the bid items under this section by the square yard acceptably completed. The department will measure fillets for widened sections or fillets at drain basins and similar locations if placed monolithic with the concrete base. The department will not deduct for fixtures located within the limits of the concrete base.

320.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
320.0100 - 0199	Concrete Base (inch)	SY
320.0300 - 0399	Concrete Base HES (inch)	SY
320.0500	Concrete Base Widening	SY

- (2) Payment for the Concrete Base and Concrete Base HES bid items is full compensation for providing curing, and protecting concrete; and for providing dowels and tie bars. Payment also includes preparing the foundation except, if the contract contains the Prepare Foundation for Concrete Base bid item, the department will pay separately for preparing the foundation under [211.5](#).
- (3) Payment for Concrete Base Widening is full compensation for preparing the foundation; for excavating and reconstructing shoulders and slopes; for disposing of unused excavated material; and for providing, curing, and protecting concrete.

SECTION 325 PULVERIZED AND RE-LAID PAVEMENT

325.1 Description

- (1) This section describes full depth in-place pulverizing of the existing asphaltic pavement along with a portion of the underlying base and relaying the pulverized material to construct a new base.

325.2 (Vacant)

325.3 Construction

- (1) Pulverize the full depth of the existing asphaltic pavement until 97 percent or more will pass the 2-inch (50 mm) sieve. Also pulverize the existing base to the depth the plans show and mix with the pulverized asphaltic pavement. Windrow material as construction operations dictate.
- (2) Immediately after pulverizing, relay the material with a paver, grader, or both a paver and grader.
- (3) If sufficient material is available at a given location, match the lines, grades, and cross slopes the plans show. If there is insufficient material at a given location, shape the available material to create a smooth profile and cross slope for a good ride. Eliminate localized bumps, depressions, and ruts. Unless the engineer specifically directs, the contractor is not required to haul material from one location on the project to another.
- (4) Immediately after relaying, compact the re-laid material first with either a rubber tired roller or vibratory padfoot roller and second with a vibratory steel roller. Add water, as required, both before and during compaction. Compact each layer to the extent required for standard compaction under [301.3](#). Use compaction equipment as follows:
 1. For a compacted lift of 6 inches (150 mm) or less, use equipment as specified in [301.3.1](#).
 2. For a compacted lift from 6 inches (150 mm) to 8 inches (200 mm), use a 12.5-ton (11.3 Mg) or heavier vibratory padfoot roller and an 8-ton (7.25 Mg) or heavier vibratory steel roller.
 3. For a compacted lift greater than 8 inches (200 mm), split into lifts less than 8 inches (200 mm) and use the equipment specified for those lift thicknesses.
- (5) Perform each day's pulverize and relay operations to avoid leaving abrupt longitudinal differences between adjacent lanes. Repair surface damage caused by intervening construction or public traffic immediately before paving as necessary to provide a good riding pavement.

325.4 Measurement

- (1) The department will measure Pulverize and Relay by the square yard acceptably completed, measured using the centerline length and the width from outside to outside of completed base, but limited to the width the plans show or the engineer directs.

325.5 Payment

- (1) The department will pay for the measured quantity at the contract unit price under the following bid item:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
325.0100	Pulverize and Relay	SY

- (2) Payment is full compensation for pulverizing, windrowing, relaying, furnishing and adding water, shaping, and compacting. If the engineer requires hauling material from one location on the project to another, the department will pay for that hauling as extra work.
- (3) Payment also includes water for compaction and dust control except, if the contract contains the Water bid item, the department will pay separately for compaction and dust control water as specified in [624.5](#).

SECTION 330 MILLED AND RE-LAID PAVEMENT

330.1 Description

- (1) This section describes partial depth in-place milling of the existing asphaltic pavement and relaying the milled material to construct a new base.

330.2 (Vacant)

330.3 Construction

- (1) Mill the existing asphaltic pavement to the depth the plans show and until 100 percent will pass the 1 1/2 inch (37.5 mm) sieve. Windrow material as construction operations dictate.
- (2) Immediately after milling, relay the material with a paver, grader, or both a paver and grader.
- (3) Match the lines, grades, and cross slopes the plans show. Eliminate localized bumps, depressions, and ruts. Unless the engineer specifically directs, the contractor is not required to haul material from one location on the project to another.
- (4) Immediately after relaying, compact the re-laid material first with either a rubber tired roller or vibratory padfoot roller and second with a vibratory steel roller. Add water, as required, both before and during compaction. Compact each layer to the extent required for standard compaction under [301.3](#). Use compaction equipment as follows:
 1. For a compacted lift of 6 inches (150 mm) or less, use equipment as specified in [301.3.1](#).
 2. For a compacted lift from 6 inches (150 mm) to 8 inches (200 mm), use a 12.5-ton (11.3 Mg) or heavier vibratory padfoot roller and an 8 ton (7.25 Mg) or heavier vibratory steel roller.
 3. For a compacted lift greater than 8 inches (200 mm), split into lifts less than 8 inches (200 mm) and use the equipment specified for those lift thicknesses.
- (5) Perform each day's mill and relay operations to avoid leaving abrupt longitudinal differences between adjacent lanes. Repair surface damage, caused by intervening construction or public traffic, immediately before paving as necessary to provide a good riding pavement.

330.4 Measurement

- (1) The department will measure Mill and Relay by the square yard acceptably completed, measured using the centerline length and the width from outside to outside of completed base, but limited to the width the plans show or the engineer directs.

330.5 Payment

- (1) The department will pay for the measured quantity at the contract unit price under the following bid item:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
330.0100	Mill and Relay	SY

- (2) Payment is full compensation for milling, windrowing, relaying, furnishing and adding water, shaping, compacting, and removing and disposing of excess material. If the engineer requires hauling material from one location on the project to another, the department will pay for that hauling as extra work.
- (3) Payment also includes water for compaction and dust control except, if the contract contains the Water bid item, the department will pay separately for compaction and dust control water as specified in [624.5](#).

SECTION 335 RUBBLIZED PAVEMENT

335.1 Description

- (1) This section describes rubblizing and compacting existing concrete pavement to create a stable construction platform for a pavement overlay either with or without an intermediate base layer.

335.2 Materials

- (1) Furnish filler aggregate conforming to [305.2](#). Use either 1 1/4-inch (31.5 mm) or 3/4-inch (19.0 mm) base material.

335.3 Construction

335.3.1 General

- (1) Use self-contained, self-propelled breakers. Use 10-ton (9 Mg) or heavier rollers and roll at 6 feet per second (2 m/s) or slower. Run vibratory rollers at an engineer-approved frequency and amplitude. A roller pass is defined as down and back in the same path.
- (2) Before rubblizing, saw full depth joints and completely sever all load transfer devices to isolate the rubblizing area. Saw jointed pavements at an existing joint. Do not damage adjacent pavement during rubblization. Repair damage to the adjacent pavement caused by contractor operations as the engineer directs.
- (3) Use water to control dust until overlaying the rubblized pavement.

335.3.2 Rubblizing

- (1) Break concrete uniformly across the pavement width into particles that have a maximum dimension less than or equal to 12 inches (300 mm). Also, 75 percent of the particles, as the engineer determines visually, must have a maximum dimension less than or equal to the following:
 - In the bottom half of the slab; 9 inches (230 mm).
 - In the top half of the slab; 3 inches (75 mm).
 - At the surface of the slab; 2 inches (50 mm).
- (2) The engineer may direct or allow larger maximum particle dimensions.
- (3) Determine particle size by excavating 2 test holes, of about 9 square feet (1 m²) each, during the first half day. Excavate at least one test hole per lane mile thereafter unless the engineer directs or allows otherwise. Backfill and restore the stability of each test hole.
- (4) Do not damage pipes, valve boxes, manholes, and other fixtures. The contractor may prevent damage by doing one or more of the following:
 1. Use engineer-approved, modified methods around fixtures and above pipes.
 2. Remove pavement around fixtures and above pipes, backfill with aggregate, and compact.
- (5) Repair damage to pipes, valve boxes, manholes, and other fixtures as the engineer directs.
- (6) Remove reinforcing steel exposed at the surface by cutting below the surface and disposing of the steel as specified in [203.3.4](#). Do not remove unexposed reinforcing steel.

335.3.3 Compacting

- (1) Compact the rubblized area using 2 passes with a vibratory steel roller. The engineer may adjust the number of passes to achieve the desired compaction and stability.
- (2) Remove loose asphaltic patching material, joint fillers, expansion material, or other similar materials from the compacted surface. Also remove pavement or patches that have a maximum dimension greater than or equal to 6 inches (150 mm) that are either not well seated or projecting more than one inch (25 mm). Dispose of removed material as specified in [203.3.4](#).
- (3) Fill holes and localized depressions, deeper than 2 inches (50 mm), with filler aggregate and compact as the engineer directs.
- (4) If paving with no intermediate base layer, roll the entire surface additionally, unless the engineer directs or allows otherwise, as follows:
 1. One pass with a pneumatic-tired roller.
 2. One pass with a vibratory steel roller immediately before paving.

335.4 Measurement

- (1) The department will measure Rubblizing by the square yard acceptably completed.

335.5 Payment

- (1) The department will pay for the measured quantity at the contract unit price under the following bid item:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
335.0100	Rubblizing	SY

- (2) Payment is full compensation for rubblizing; removing pavement adjacent to fixtures or above pipes; removing exposed steel; compacting; disposing of removed material; excavating, backfilling, and restoring the stability of test holes; and repairing damage to pipes, fixtures, and the adjacent pavement.
- (3) Payment also includes water for dust control except, if the contract contains the Water bid item, the department will pay separately for dust control water as specified in [624.5](#).
- (4) The department will pay separately for sawing under the Sawing Concrete Pavement Full Depth bid item as specified in [690.5](#).
- (5) The department will pay separately for filler aggregate under the Base Aggregate Dense bid items. This payment includes furnishing, placing, and compacting aggregate used to fill holes and depressions.

SECTION 340 CRACKED AND SEATED PAVEMENT

340.1 Description

- (1) This section describes cracking and seating existing concrete pavement to create a stable construction platform for a pavement overlay.

340.2 (Vacant)

340.3 Construction

340.3.1 Equipment

- (1) Use a spade or guillotine type breaker mounted on a vehicle and capable of controlled forward and transverse movement. The breaker must be capable of exerting a minimum of 12,000 foot-pounds (16.3 kN-m) of energy.
- (2) Use 10-ton (9 Mg) or heavier vibratory rollers operated at an engineer-approved frequency and amplitude.

340.3.2 Cracking and Seating

- (1) Crack the pavement full depth while maintaining aggregate interlock between the pieces. Do not unduly displace the concrete; damage drainage facilities, utilities, or other property; or destabilize the base or subgrade.
- (2) Crack concrete uniformly across the pavement width into pieces approximately 4 to 8 square feet (0.4 - 0.7 m²) in area and having their maximum dimension transverse to the pavement centerline. Do not crack concrete within 2 feet (0.6 m) of transverse joints, or at other locations designated by the contract or engineer.
- (3) Roll the cracked surface to firmly seat the cracked pieces and produce an even surface. Clean the surface of the cracked and seated pavement before opening to traffic and again just before placing the asphaltic leveling course. Remove dust, dirt, debris, or other foreign or loose material.

340.4 Measurement

- (1) The department will measure Cracking and Seating by the square yard acceptably completed.

340.5 Payment

- (1) The department will pay for the measured quantity at the contract unit price under the following bid item:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
340.0100	Cracking and Seating	SY

- (2) Payment is full compensation for cracking, rolling, and cleaning the concrete pavement.

SECTION 350 SUBBASE

350.1 Description

- (1) This section describes constructing a granular subbase on the prepared roadbed.

350.2 Materials

- (1) Conform to [209.2](#) for granular backfill except as follows:
 1. The maximum dimension of any particle shall not exceed 3/4 of the compacted thickness of the layer being placed.
 2. At least 25 percent of the material, by weight, shall pass a No. 4 (4.75 mm) sieve.
- (2) Procure material as specified in [209.2.4](#) from one or both of the following sources:
 - Within the right-of-way as the plans show or as allowed in [104.8](#).
 - Beyond the right-of-way as specified for borrow in [208.3](#).

350.3 Construction

350.3.1 General

- (1) Do not place loam, clay, silt, or similar soil materials on the subbase surface or incorporate into the subbase. With the engineer's approval, the contractor may use cement, fly ash, lime, or similar engineer-approved materials to stabilize the subbase.
- (2) If the contract specifies both a subbase and a flexible base, and constructing the subbase in multiple layers, construct successive layers in the sequence and at the times the engineer directs. The engineer will phase that construction to provide a usable surface for traffic.

350.3.2 Preparing Subgrade

- (1) Prepare and maintain the subgrade as specified for preparing the foundation for non-rigid base under [section 211](#). Excavate and backfill areas of soft, yielding, or spongy subgrade or otherwise treat unstable areas as the engineer directs.

350.3.3 Constructing Subbase

- (1) Place granular subbase on the prepared subgrade in a manner that minimizes contamination with the subgrade material. Do not place subbase material on a frozen subgrade, subgrade covered by ice or snow, or on a wet or soft subgrade unless the engineer specifically directs.
- (2) Compact the material as specified in [207.3.6](#) except conform to [301.3.1](#) for compaction equipment. Follow the standard compaction methods specified in [207.3.6.2](#) unless the contract requires the special compaction methods specified in [207.3.6.3](#).
- (3) Shape, and compact the subbase as it is placed. Trim the completed subbase to the lines, grades, and section the contract specifies. Remove and dispose of particles in excess of the specified maximum size. Maintain the finished subbase until it is covered over, or until the engineer accepts the work if the contract does not require covering the subbase.

350.4 Measurement

350.4.1 General

- (1) The department will measure the Subbase bid items by the cubic yard, the ton, or the square yard acceptably completed. The department will deduct for oversized particles removed as specified in [350.3.3\(3\)](#).

350.4.2 By Volume

- (1) For material measured by the cubic yard, the department will compute the volume of material in its original source position using one of the following methods:
 - Average end areas, with no correction for curvature.
 - Truncated prisms.
- (2) The department will measure the original volume after the contractor strips or otherwise prepares the deposit. Notify the engineer before removing any subbase material. The department will not measure material removed before the engineer measures the original volume.

- (3) For small quantities, the department may elect to determine the volume in the vehicle. The engineer will determine the capacity of each vehicle used to the nearest 1/10 cubic yard (0.1 m³).

350.4.3 By Weight

- (1) For material measured by the ton, the department will determine the weight based on contractor-provided tickets. Give the engineer a ticket, for each load delivered to the project, showing the net weight of the load, the type of material, the date, and project number.
- (2) For weighed material delivered with a moisture content greater than 7 percent, the department will reduce the ticket weight by the weight of water exceeding 7 percent. The department will determine moisture content based on and expressed as a percent of the dry weight.

350.4.4 By Area

- (1) For material measured by the square yard, the department will only measure areas placed to the thickness the contract specifies or the engineer directs. For subbase with sloping sides, the department will compute area based on the mean width of the top and bottom of the layer. The department will measure additions ordered to correct for settlement of the earth subgrade based on the in place volume converted to an equivalent area.

350.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
350.0102	Subbase	CY
350.0104	Subbase	TON
350.0110 - 0199	Subbase (inch)	SY

- (2) Payment for the Subbase bid items is full compensation for preparing the subgrade; for excavating, loading, and hauling material from within the right-of-way or furnishing material as required from beyond the right-of-way; and for placing, shaping, compacting, and maintaining the subbase.
- (3) The department will pay separately for erosion control, fertilizing, and seeding of subbase procurement pits and associated areas as specified for borrow pits under [628.5.1](#). All other costs associated with the procurement of material from beyond the right-of-way are incidental to the Subbase bid items.
- (4) The department will pay separately for excavating and backfilling areas of soft, yielding, or spongy subgrade under the applicable Excavation bid items as specified in [205.5](#).
- (5) The department will pay for EBS in areas of completed subbase, dust control water, and compaction water as specified under [301.5](#).

SECTION 390 BASE PATCHING

390.1 Description

- (1) This section describes patching areas of existing concrete pavement with either concrete or asphaltic mixtures for overlaying with new pavement.

390.2 Materials

- (1) The contractor may use either concrete or asphaltic mixture.
- (2) Furnish concrete conforming to the requirements specified for air-entrained high early strength concrete, grade B, B-FA, B-S, B-IS, or B-IP, under [section 501](#), except that under the Base Patching Concrete SHES bid item, conform to [416.2.6.1](#).
- (3) Furnish asphaltic mixture as specified for asphaltic base under [315.2](#).

390.3 Construction

390.3.1 General

- (1) Unless the contract provides otherwise, keep the road open to traffic during construction. If possible, restrict operations to one lane at a time. Perform work to cause the least possible inconvenience to traffic.
- (2) Remove areas of existing concrete pavement, including existing patching or surfacing materials, at locations the plans show or the engineer directs in the field. Saw the connecting edges as true and perpendicular as possible as specified for sawing pavement in [section 690](#). Remove the pavement without injury to the remaining pavement. Dispose of removed material as specified in [204.3.1.3](#).
- (3) Prepare the foundation as specified in [section 211](#) using engineer-approved hand methods. Place the patch to the thickness of the contiguous pavement, including the existing asphaltic pavement or surfacing.

390.3.2 Concrete Patching

- (1) Deposit concrete to require as little rehandling as possible, place and consolidate by hand, and strike off and finish flush with adjoining surfaces. The engineer will not require forms unless necessary to provide the required edge, grade, or alignment.
- (2) Unless the plans show or the engineer directs otherwise, the department will not require ties to the existing pavement or joints within a patch.
- (3) Cure as specified for concrete pavement in [415.3.12](#) and protect as specified for concrete pavement in [415.3.16](#). Open to traffic as specified for concrete base in [320.3](#).

390.3.3 Asphaltic Patching

- (1) Construct as specified for asphaltic base under [section 315](#) except as modified here in 390.3.3.
- (2) Dump material outside the patch area, fill the patch in successive layers with shovels, and shape to the required grade and contour with rakes and lutes. Do not rake dumped material into the patch. The engineer will not require forms unless necessary to provide the required edge, grade, or alignment.
- (3) Compact each layer with engineer-approved compaction equipment. Unless the engineer directs otherwise, compact each layer to a thickness of 6 inches (150 mm) or less. Roll the top layer until flush with the adjacent surface.
- (4) Do not open patches to traffic until they are hard enough to prevent rutting or displacement.

390.3.4 Special High Early Strength Concrete Patching

- (1) Construct as specified for special high early strength repairs under [416.3.8](#), except begin removal within 14 calendar days after cutting the existing pavement. Cure as specified for concrete pavement under [415.3.12](#), except do not apply excess curing compound that could cause slippery pavement under traffic.

390.4 Measurement

- (1) The department will measure Base Patching, Base Patching Asphaltic, and Base Patching Concrete by the ton or square yard acceptably completed.
- (2) The department will measure Base Patching Concrete SHES by the square yard acceptably completed.

390.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
390.0101	Base Patching	TON
390.0103	Base Patching	SY
390.0201	Base Patching Asphaltic	TON
390.0203	Base Patching Asphaltic	SY
390.0301	Base Patching Concrete	TON
390.0303	Base Patching Concrete	SY
390.0403	Base Patching Concrete SHES	SY

- (2) Payment for all bid items under this section is full compensation for removing old pavement and disposing of removed materials; for preparing the foundation; for providing, curing, and protecting concrete; and for providing and compacting asphaltic mixture, including the asphaltic material. Payment includes providing and placing tie bars and dowel bars in unhardened concrete and all steel within the patch.
- (3) Base Patching includes providing either concrete or asphalt at the contractor's option. Base Patching Asphaltic includes providing asphaltic material. Base Patching Concrete and Base Patching Concrete SHES include providing concrete.
- (4) Payment for Base Patching Concrete SHES is also full compensation for making and testing concrete cylinders and providing test data to the engineer.
- (5) The department will pay for sawing the existing concrete pavement for removal under the Sawing Existing Pavement or Sawing Concrete Pavement Full Depth bid items as specified in [690.5](#).
- (6) For tie and dowel bars placed in existing pavement, the department will pay for tie bars under the Pavement Ties bid item and dowel bars under the Pavement Dowel Bars bid item as specified in [416.5](#).
- (7) If the engineer orders the contractor to excavate yielding or unstable subgrade materials and backfill with suitable materials, the department will pay for that work either under pertinent contract bid items, or as extra work.

PART 4 PAVEMENTS

SECTION 415 CONCRETE PAVEMENT

415.1 Description

- (1) This section describes constructing a concrete pavement, with or without reinforcement, on a prepared foundation.

415.2 Materials

415.2.1 Concrete

- (1) Furnish grade A, A2, A3, A-FA, A-S, A-S2, A-T, A-IS, or A-IP, air-entrained concrete conforming to [section 501](#). Furnish high early strength concrete if the plans show or the special provisions require. If the contract does not specify high early strength concrete, the contractor may, at no expense to the department, use high early strength concrete.

415.2.2 Reinforcement

- (1) Furnish steel reinforcement conforming to [section 505](#). Furnish dowel bars and tie bars as the plans show and conforming to [505.2.6](#).

415.2.3 Expansion Joint Filler

- (1) Furnish expansion joint filler conforming to AASHTO M 153 or AASHTO M 213.
- (2) Furnish the filler in lengths equal to the width of the pavement lanes, and to the thickness and height that the plans show. If dowel bars are required, use filler with clean-cut punched holes, not greater than 1/8 inch (3 mm) larger in diameter than the nominal size of the dowel bar the plans require.

415.2.4 Concrete Curing Agents

- (1) Furnish liquid curing compound conforming to AASHTO M 148, type 2, except for water retention testing. The department will conduct water retention tests according to AASHTO T 155, except as follows:
 1. The department will not seal the edges of the specimen.
 2. The department will apply the curing compound at one gallon per 200 square feet (0.20 L/m²) of surface or at the manufacturer's recommended rate whichever is greater.
- (2) Furnish polyethylene sheeting conforming to AASHTO M 171 for white opaque polyethylene film.
- (3) Furnish burlap conforming to AASHTO M 182, class 3 or 4. The contractor may use 2 layers of class 1 or class 2 instead of one layer of class 3 or class 4.
- (4) Furnish polyethylene-coated burlap conforming to AASHTO M 171 for white burlap-polyethylene sheets.

415.2.5 Calcium Chloride

- (1) Furnish calcium chloride for use in concrete for pavements as follows:
 1. For use in solid form or on the job preparation of admixture solutions, conform to AASHTO M 144, type S, grade 1 or grade 2.
 2. For admixture delivered in premixed solution form, conform to AASHTO M 144, type L, in a concentration of approximately 30 percent.

415.2.6 Epoxy Grout

- (1) Furnish epoxy grout consisting of a 2-component epoxy material of contrasting colors and conforming to AASHTO M 235, grade 3 - non-sagging consistency, type IV epoxy, except as modified below:
 1. Use class B material for mid-depth slab temperatures between 41 F and 61 F (5 C and 16 C).
 2. Use class C material for mid-depth slab temperatures between 61 F (16 C) and the highest temperature allowed by the manufacturer of the product.
- (2) Bond strength, tensile strength, and elongation testing is not required.
- (3) Achieve a minimum compressive yield strength of 5000 pounds per square inch (34.5 MPa) at 8 hours for special high early strength concrete, or at 3 days for grades A, C, and E concrete. Test according to AASHTO M 235 and ASTM D 695, with the following restrictions:
 1. Mold and cure compressive test specimens in cylinders with a one-inch (25 mm) nominal diameter.
 2. Machine specimen ends square to produce a final specimen length of 2 inches (50 mm).

- (4) Submit to the engineer, before using the epoxy grout, a manufacturer's certification, include test reports from a qualified independent laboratory, showing that the product conforms to all above requirements. Clearly identify the temperature classes and compressive strength cure times for which the product is certified.

415.2.7 Weighing, Batching, Mixing, and Hauling Equipment

- (1) Conform to [section 501](#).

415.3 Construction

415.3.1 Equipment

415.3.1.1 Concrete Spreader

- (1) Use a self-propelled machine with sufficient power and traction to spread and strike off the concrete to the desired cross section. If constructing slip-formed pavement, operate the spreader on wheels or crawler tracks. If constructing fixed-formed pavement, operate the spreader on the forms.
- (2) Use a spreader equipped with a power-driven device that spreads the concrete uniformly between the tracks or forms, and capable of striking off in the longitudinal direction of the slab, at any required elevation. Use one or more of the following spreading devices:
 - Reciprocating blade.
 - Screw conveyor.
 - Belt conveyor.
- (3) The engineer may approve the use of mechanically operated concrete spreaders of other designs, if capable of uniform distribution and minimal segregation.

415.3.1.2 Concrete Finishing Machine

- (1) Use an engineer-approved, self-propelled slip-form paving machine designed to consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the machine to minimize the necessary hand finishing to produce a dense, homogeneous pavement. Use machines equipped to vibrate the concrete for the full width and depth of the course placed in a single pass, and designed and constructed so no spreading or appreciable slumping of the concrete occurs. Use a concrete spreader, conforming to 415.3.1.1, ahead of a slip-form paver that cannot otherwise satisfactorily spread, consolidate, or finish the concrete. Equip the slip-form paver with a mechanical device that accurately spaces and positions the required tie bar reinforcement and that allows satisfactory mechanical or manual tie bar insertion.
- (2) Use a self-propelled finishing machine for formed concrete pavement with sufficient power and traction to move at a uniform speed without slipping. Use a screeding and troweling type machine equipped with at least 2 oscillating transverse screeds, adjustable for tilt and crown, and designed to both strike off and consolidate the concrete.
- (3) If using a finishing machine to both spread and strike off the concrete, equip it to spread the concrete uniformly with a minimum of segregation and to strike off the concrete at the required elevation.
- (4) The contractor may use finishing machines that do not conform to these requirements but are specifically designed for finishing concrete pavement or bridge decks to finish minor amounts of concrete pavement with the engineer's written permission. These machines must produce equivalent results including adequate consolidation by internal vibration and an acceptable finish.

415.3.1.3 Paving Vibrators

- (1) For full width consolidation of concrete pavement, use either the surface pan vibrator or the internal vibrator with either immersed tube or multiple spuds. Obtain the engineer's approval of the vibratory equipment. Use vibrators that do not come in contact with the forms or joint assemblies. Operate surface pan type vibrators at a minimum frequency of 4000 impulses per minute. Operate internal type vibrators at a minimum frequency of 5000 impulses per minute for tube vibrators and 7000 for spud vibrators.
- (2) To consolidate concrete pavement that is adjacent to forms, joints, or fixtures, use single spud type internal vibrators, either hand operated or attached to spreaders or finishing machines. Operate the vibrator at a minimum frequency of 7000 impulses per minute.
- (3) Use vibrators capable, when operated according to the manufacturer's recommendations and [415.3.11.2](#), of thoroughly and uniformly consolidating the concrete for its full width and depth.

415.3.1.4 Float Finishers for Formed Pavement

- (1) Use an engineer-approved longitudinal or transverse type float finisher adjustable to conform to the required crown and grade, and capable of producing the required surface finish.
- (2) If using a mechanical longitudinal float, use a rigidly constructed, self-propelled machine operating on the forms, equipped with a power-driven floating screed. Ensure that the screed oscillates longitudinally with respect to the pavement during its transverse travel across the pavement.
- (3) If using a transverse float finisher, use a float, consisting of a rigid frame carried on wheels that ride on the forms, attached to and propelled by a finishing machine or by a machine designed for the purpose. Provide a transverse cutting screed or screeds, and a transverse smoothing float suspended from and guided by the frame.
- (4) If allowed to use manually operated floats instead of mechanical floats, use rigidly constructed floats. Provide floats at least 10 feet (3 m) in length with a base at least 6 inches (150 mm) in width.

415.3.1.5 Tube Float

- (1) A tube float consists of a suitable tube mounted on a self-propelled unit. Use a tube adjustable in either diagonal direction, up or down, and to the required pavement crown.

415.3.1.6 Forms

- (1) Unless specified otherwise, only use steel side forms of an engineer-approved cross section, constructed to ensure rigidity under impact, thrust, and mass of the equipment operating on them. For each 10-foot (3 m) section, secure at least 3 flange braces to the base and the vertical member, and fit not less than 3 stake pockets with pin anchoring keys. Use forms with a vertical face height of not less than the specified edge thickness of the pavement and a base width of 8 inches (200 mm) or more. Furnish the ends of each section with devices for interlocking the sections to form a rigid and secure joint. Use straight and true forms that, when tested with a 10 foot (3 m) straightedge, do not vary more than 1/8 inch (3 mm) along the top and no more than a 1/4 inch (6 mm) along the face. Discard, or repair and straighten bent or damaged forms to conform to these tolerances.
- (2) Use built-up forms, as the engineer allows, consisting of regular pavement forms fitted on the bottom, in an engineer-approved manner, with metal or wood plates. Use full-length plates at least 8 inches (200 mm) wide.

415.3.2 Foundation

- (1) Prepare the foundation according to [section 211](#). Before placing concrete, repair and re-compact rutted or disturbed areas of the foundation resulting from hauling or paving operations as specified in [section 211](#). If the contractor fails or neglects to perform the required repair of damaged foundation, the engineer may suspend paving operations until the contractor performs satisfactory reconditioning of the foundation.

415.3.3 Setting Forms

- (1) Set forms to the required grade and alignment. Cut the foundation under the forms true to grade and make firm, so the form is firmly in contact for its whole length and at the desired grade. Correct any foundation that, at the form line, is below established grade. Fill the foundation to grade in lifts of one inch (25 mm) or less, for a distance of 18 inches (500 mm) on each side of the base of the form, and re-roll and tamp. Correct imperfections and variations above grade by tamping or by cutting, as necessary. Always tamp the material under the forms thoroughly after setting the form. The engineer will shut down operations if observing any settlement or springing of forms under the finishing equipment.
- (2) Use at least 3 pins for each 10-foot (3 m) length to stake forms. Use pins of a length that, if driven in place, are firm and rigid, and prevent movement in the forms. Drive pins into the stake pockets of the forms, and securely fasten the forms to each pin with adequate locking devices. Join the form sections with a locked joint that is free from play or movement in any direction.
- (3) Check that forms conform to alignment and grade, and make necessary corrections before placing the concrete. If a form has been disturbed, reset and recheck the form.
- (4) Set and maintain forms, to the extent practical, for at least 1200 square yards (1000 m²) of pavement before the point of placing concrete. Clean and oil forms before each use.
- (5) Use built-up forms instead of full-depth side forms if the total area of concrete pavement of any specified thickness on a project is less than 200 square yards (1700 m²).

- (6) Use wood side forms for forming fillets, widening strips at intersections, curves of less than 100 foot (30 m) radius, and where the use of metal paving forms is impractical. Provide wood forms made from sound lumber, free from cracks or other blemishes, surfaced at least on the concrete face and top edge and, except for forming curves of less than 100 foot (30 m) radius, of not less than 2 inch (50 mm) nominal stock. Do not allow the variation of the top of forms from a true plane to exceed 1/8 inch (3 mm). Do not allow the variation of the face of forms from a true plane to exceed 1/4 inch in 10 feet (6 mm in 3 m).
- (7) Use flexible or curved forms of proper radius for curves of 100 feet (30 m) radius or less. For flexible or curved forms, use either wood or metal of ample strength to produce completed work conforming to the alignment, grade, and surface tolerance required. Place and stake, insofar as it is practical, as specified for steel forms in [415.3.1.6](#) and [415.3.3](#) and as the engineer approves.

415.3.4 Handling, Measuring, and Batching Materials

- (1) Conform to [section 501](#) and the additional requirements specified here in 415.3.4.
- (2) Proportion aggregates and cement for concrete pavement in batching plants by weight. Use semi-automatic or automatic batching plants on contracts involving 15 000 square yards (12 500 m²) or more of concrete pavement.
- (3) On contracts involving less than 15 000 square yards (12 500 m²) if furnishing a semi-automatic or automatic plant, provide a plant conforming to the pertinent requirements of [501.3.4](#).

415.3.5 Mixing

- (1) Conform to [section 501](#).

415.3.6 Consistency

- (1) Maintain a uniform consistency in consecutive batches of concrete. Perform slump tests according to AASHTO T 119. Use the following slumps for the technique used:

SLIP-FORMED	NOT SLIP-FORMED WITH INTERNAL VIBRATION	NOT SLIP-FORMED WITH SURFACE VIBRATION
2.5 inches (65 mm) or less	One to 3 inches (25 to 75 mm)	1.5 to 3 inches (38 to 75 mm)

- (2) The contractor need not test slump for slip-formed work except as the engineer requests.

415.3.7 Placing Concrete

415.3.7.1 General

- (1) Deposit concrete on the foundation from the mixer or hauling equipment across the full width of the pavement in a manner that minimizes required spreading and minimizes segregation in the concrete mix.
- (2) Distribute concrete to a depth sufficiently above grade so, after consolidating and finishing, the required slab thickness is obtained at all points and the surface conforms to the specified grade and slope.
- (3) Adjust and set castings and frames for manholes, catch basins, inlets, and other fixtures to the required alignment and grade while the adjacent concrete is still plastic.
- (4) Spade or vibrate concrete placed against the faces of fixtures to prevent the formation of voids and to fill openings between the bases of the fixtures and their support structures.
- (5) The contractor may set the castings and frames for manholes, catch basins, and inlets, on a full bed of mortar and adjust to the required alignment and grade before placing concrete. The contractor may also use an engineer-approved non-shrink pressure grout to fill all remaining voids beneath the base of these fixtures before opening the adjacent pavement to traffic.
- (6) Continuously place concrete between transverse joints, do not use intermediate bulkheads. If a temporary shutdown occurs, cover the concrete at the unfinished end of the slab with wet burlap. Install a construction joint if an interruption exceeds 30 minutes or is long enough that the concrete deposited attains its initial set. Do not place sections of pavement less than 10 feet (3 m) in length between joints.
- (7) If constructing continuously reinforced pavement, install the construction joint header as specified for transverse joints in [415.3.9.2](#). After installing the header, wait 8 hours before resuming concrete placement, unless the engineer directs otherwise.
- (8) Immediately repair any damage to the slab resulting from header removal or subsequent operations.
- (9) Discontinue concrete placement if finishing equipment breaks down, the time sequence of finishing and curing operations is not kept, or if materials, work quality, or the resultant product are substandard.

- (10) Deposit concrete at joint installations so as not to displace or disarrange the installations. Completely fill the joint assemblies with concrete. Simultaneously place concrete on both sides of expansion joints. Deposit the concrete at and in advance of contraction joint assemblies to preclude the formation of segregated or laitance-bearing concrete in the assembly.
- (11) Unless specified otherwise, place pavement of rural cross section to its full plan width in a single construction operation. For pavement constructed directly on open graded base, the contractor may place pavement to a single lane width in a single operation.
- (12) Do not place temporary gaps in continuously reinforced pavement unless the contract specifies or the engineer directs. If unable to pave the gap beforehand, use additional reinforcement as specified for placing continuous pavement reinforcement in [415.3.8.2](#) and stabilize the concrete temperature in the free ends of the pavement by applying a double layer of burlap to the pavement surface for a distance of 200 feet (60 m) from each free end. Keep the burlap wet and in place for at least 24 hours just before paving the gap and until the curing time has expired for the newly placed adjacent pavement.
- (13) Make the longitudinal construction joint between lanes or sections less than or equal to 1/2 inch in 10 feet (13 mm in 3 m) from the true line. Edge the joint to a 1/4-inch (6 mm) radius.
- (14) Only place concrete in a subsequent lane if capable of avoiding damage to the previously constructed lane. When placing concrete adjacent to previously constructed pavement, provide that part of the equipment supported on the existing pavement with protective pads, crawler tracks, or rubber-tire wheels and operate a sufficient distance from the edge of the pavement to avoid breaking the pavement edge. Do not operate this equipment on the pavement surface until opening to service as specified in [415.3.17](#).
- (15) Exclude equipment, other than paving equipment as specified above, from the previously constructed lane or lanes until, as specified for opening to service in [415.3.17](#), after the expiration of the required number of days or until attaining the required strength.
- (16) If moving or operating paving equipment on concrete bridge decks, asphaltic pavement or surfacing, or concrete pavements, employ appropriate means to prevent damage to the bridge decks or pavements.

415.3.7.2 Pavement Constructed with Ready-Mixed Concrete

- (1) Facilities for the production and delivery of ready-mixed concrete shall ensure placement at a uniform rate of not less than 80 cubic yards (60 m³) per hour, unless performing single-lane construction.
- (2) As practical, use delivery vehicles operating outside the lane or lanes being placed to deposit the concrete on the prepared subgrade. If the engineer allows the delivery vehicle to operate in the lane in which the concrete is being placed, provide means to satisfactorily correct irregularities and to restore the foundation as necessary before placing concrete. If placing fixed-formed pavement, operate a subgrade planer just ahead of the deposited concrete. If using slip-form methods, use engineer-approved methods or equipment to restore the subgrade satisfactorily.

415.3.7.3 Formed Pavement

- (1) Spade or vibrate placed concrete along the faces of forms to prevent voids.
- (2) Use single or multiple spud vibrators to consolidate the concrete along the full length of all transverse joint assemblies. Vibrate to a depth that consolidates the concrete above and below the dowel bars and assembly, unless installing dowel bars using engineer-approved machine methods during placement. If spud vibrators are an integral part of the paver, set them to clear the dowel bar assembly and ensure they are capable of consolidating the concrete to full depth.
- (3) Use hand vibrators on concrete adjacent to all transverse construction joints.
- (4) Vibrate along forms, fixtures, and joints according to [415.3.1.3](#). Do not allow vibrators to contact a joint assembly, the grade, or a side form. Vibrate the concrete adjacent to joint assemblies to preclude displacing the dowels or other parts of the assembly. Do not operate the vibrator in one location for longer than required to bring grout to the surface of the immediate area. Immediately fill all voids or rock pockets of more than casual occurrence, found after removing the forms, with a well-mixed grout, composed of one part portland cement and 3 parts fine aggregate. Finish these areas to the true surface of the edge of the pavement slab.

415.3.7.4 Slip-Formed Pavement

- (1) Coordinate the mixing, delivering, and spreading operations to provide uniform progress. Stop and start the paver as little as possible.
- (2) Vibrate concrete adjacent to transverse construction joints with hand vibrators.

415.3.8 Reinforcement

415.3.8.1 General

- (1) Reinforce the concrete if and as the plans specify. Keep reinforcement clean and free from rust scale, straight and free from distortion. Store all reinforcement steel, received on the job, in engineer-approved storage and distribute only as needed for immediate placement.

415.3.8.2 Placing Continuous Pavement Reinforcement

- (1) Place the bar steel reinforcement after properly preparing the subgrade. Place the longitudinal bars on top of the transverse bars and firmly tie or fasten together at each intersection. Support the assembled bars on bar chairs at a depth the plans show. Bar chairs are subject to the engineer's approval. They shall be sufficient in strength and number to hold the steel reinforcement in position during construction.
- (2) Splice longitudinal bars by lapping, as the plans show, and firmly tie or fasten together. Arrange splices as the plans show. Install additional steel reinforcement, as the plans show at construction joints.
- (3) Protect all bar steel reinforcement left protruding from the slab for any extended period from deterioration caused by exposure.
- (4) Do not bend bar steel reinforcement or subject to loading or forces that distort the steel or weaken the bond to the concrete.
- (5) Tie coated bars using a procedure, equipment, and materials that do not damage or cut the coating. Use one or more of the following materials to tie coated bars:
 - Engineer-approved plastic or nonmetallic material.
 - Stainless steel wire.
 - Nylon, epoxy, or plastic-coated wire.

415.3.9 Jointing

415.3.9.1 Longitudinal Joints

- (1) Construct longitudinal joints as and where the plans show. If the plans do not show a specific location, construct parallel to the centerline along lane edges. On two-lane pavements, construct them along the pavement centerline. On multi-lane pavements, construct them along traffic and taper lane edges. Make joints perpendicular to the pavement surface. Do not deviate more than 1/2 inch in 10 feet (13 mm in 3 m) from the required line. Longitudinal joints may consist of construction joints where new work joins existing work. Saw all other longitudinal joints.
- (2) Saw joints within 36 hours after placing concrete. If covering the pavement for cold weather protection, the contractor may delay sawing to avoid early exposure to freezing conditions.
- (3) Tie new work to existing concrete pavement using tie bars driven into the existing pavement. Use only cast-in-place tie bars in construction joints of pavement placed under the contract.

415.3.9.2 Transverse Joints

- (1) Construct as specified in the plan details. Construct contraction, construction, or expansion joints at the locations the contract specifies, or as the engineer directs.
- (2) Unless the plans show otherwise or the engineer directs, install all transverse joints perpendicular to the pavement surface and continuous through adjacent lanes and contiguous curb & gutter.
- (3) Hold dowel bars in the correct position and alignment using an engineer-approved device during construction. Do not allow bonded longitudinal bars or reinforcement to extend across transverse expansion or contraction joints. The contractor need not cut dowel basket tie wires.
- (4) If using a mechanical device to install dowel bars, conform to the following:
 1. Place and consolidate the pavement to full depth before inserting the dowel bars.
 2. Insert the dowel bars into the plastic concrete in front of the finishing beam or screed.
 3. Ensure that the installing device consolidates the concrete with no voids around the dowel bars.
 4. Locate the dowel bars within one inch (25 mm) of the planned transverse location and depth.
 5. Locate the dowel bars within 2 inches (50 mm) of the planned longitudinal location.
 6. Place dowel bars parallel to the pavement surface and centerline within a tolerance of 1/2 inch in 18 inches (13 mm in 450 mm).

7. Do not interrupt the forward movement of the finishing beam or screed while inserting the dowel bars.
 8. Provide a positive method of marking the locations of the transverse joints.
- (5) For expansion joints, use joint filler conforming to [415.2.3](#) and extending from the foundation to 1/2 inch (13 mm) below the finished pavement surface, with its respective edges conforming to the contour of the subgrade and the pavement surface. Use material with factory-punched holes for and at the exact location of the dowel bars. During installation, protect the upper edge of the filler with an engineer-approved tight-fitting, removable metal channel cap having flanged edges of not less than 1 1/2 inches (38 mm) in depth. Upon completion of the finishing operations and after the concrete has set sufficiently, remove the cap, and round the edges of the joint with an engineer-approved edging tool.
 - (6) Form a construction joint by setting a header board securely in place at the end of each day's run or when an interruption in the concreting operation of 30 minutes or more occurs. Design and set the header board to accommodate proper placement of the tie bars or reinforcement.
 - (7) Use only production quality concrete in the header. Do not deposit segregated concrete carried ahead by the screed of the finishing machine at the header. While placing and finishing the concrete at the header, protect the steel projecting beyond the header from spilled concrete. Protect the steel from all loadings or forces that might displace or bend the steel or weaken the bond with the concrete. Use hand vibrators to consolidate the concrete against the header or concrete face at the transverse construction joint to prevent the formation of voids or rock pockets.
 - (8) If placing continuously reinforced pavement, design the header board for ready disassembly. Keep the header in place for at least 8 hours, unless the engineer allows otherwise. Secure, support, and protect the reinforcement steel immediately beyond the joint and before the next splice to preclude movement until after removing the header and completing the subsequent concrete placement.
 - (9) Upon removal of side forms, completely remove all struts or fins of concrete extending across the joint.
 - (10) Complete the sawing of contraction joints for each day's pour by approximately midnight of the same day if normal or rapid concrete setting conditions prevail. If cool weather or other conditions cause retarded setting of the concrete, delay sawing for as long as the engineer directs, to preclude tearing of the concrete adjacent to the joint, or cracking of the concrete during the sawing. Provide artificial light if joint sawing after daylight hours.
 - (11) Saw the joints, in a single cut, to the width and depth the plans show, as soon as the saw can be operated without damaging the concrete and before random cracking occurs. The contractor may temporarily hand tool joints to prevent premature cracking. Permanently saw all hand tooled joints to the plan depth as soon as possible. The engineer may direct the contractor to saw joints by the skip method, wherein every third joint is sawed as soon as possible. Following this skip sawing, make the cuts of the remaining intermediate joints as soon as possible.

415.3.10 (Vacant)

415.3.11 Consolidating and Finishing

415.3.11.1 General

- (1) Sequence operations as follows: strike-off, consolidation, screeding, float finishing, straightedging, and final surface finish.
- (2) Use the machine method of strike-off and consolidation. The contractor may, if the engineer allows, use hand methods for areas with variable slab width, for strips or lanes of pavement uniformly less than 10 feet (3 m) wide, for transition sections on curves or at other points with variable pavement crown, and for other areas if impractical to use machine methods. Immediately clean finishing equipment and tools after use, and maintain them in satisfactory condition during use.

415.3.11.2 Strike-Off and Consolidation - Machine Methods

415.3.11.2.1 General

- (1) Strike off and screed the concrete, as soon as placed, with engineer-approved machine equipment. Strike off and screed to the crown and cross section the plans show and to an elevation slightly above grade so that, when properly consolidated and finished, the surface of the pavement shall be at the required grade elevation and free from porous areas.
- (2) Unless the plans show otherwise, construct pavements on curves as a plane surface with a unidirectional cross slope. Transition from the normal crown section to the unidirectional slope and back to the normal crown section smoothly over the distance the engineer specifies. Prepare the foundation surface parallel to the pavement surface to yield the required pavement thickness throughout the curve and transition.

- (3) Make available ample personnel and equipment to maintain the strike-off, consolidation, and finishing operations within their proper time sequence. If the delivery rate of concrete is so great that, strike-off and consolidation cannot be performed, within the proper time sequence by one finishing machine, reduce the rate of production, or use an additional spreader or finishing machine. Provide and make available hand strike-off equipment in case of finishing machine breakdowns, to strike off and consolidate concrete in place on the grade, and to complete the operations to a construction joint.

415.3.11.2.2 Fixed-Form Pavement

- (1) Make as many passes, at the necessary intervals, with the machine as required to take advantage of concrete conditions, provide proper consolidation, and leave a uniform surface, true to grade and contour. Avoid prolonged operations over any given area. Use a device attached to the machine to keep the top of the forms free of accumulations of concrete or other materials. Maintain the forms so the travel of the machine is true without lifting, wobbling, or other variation that affects a precise finish. Carry a uniform load of concrete on the forward screed on the first trip or strike-off movement extending a minimum of 4 inches (100 mm) above the planned pavement surface. Operate the machine so it does not overrun the forward limit of the puddled concrete, or pass over partially filled areas.
- (2) Stop the machine when the forward screed is approximately 12 inches (300 mm) from a preinstalled transverse expansion joint. Remove all excess concrete and aggregate ahead of the screed and on the joint, and shovel forward of the joint. Lift the forward screed, and bring it directly above the joint, set it down and continue screeding operations. Lift the second screed over the joint if it is close enough to push the excess mortar in front of it onto the joint. Do not lift the screeds over the joint on subsequent passes of the finishing machine. Take care to avoid depositing segregated coarse aggregate on top of the joint or immediately between the joint and the screed.
- (3) Carry a sufficient amount of concrete forward of the first screed to fill low areas that are apparent after the machine's first strike-off movement. Maintain continuity of the forward movement of the machine. Make the last trip for a given area a continuous run of at least 40 linear road feet (12 m) of pavement. Delay the last trip of the finishing machine until after correcting irregularities in settlement or differentials in shrinkage in the freshly laid concrete. Do not delay an excessive period that causes tearing or marring of the surface results.
- (4) The contractor may use vibratory equipment, conforming to [415.3.1.3](#), to consolidate the concrete, except for continuously reinforced pavement. Consolidate continuously reinforced pavement by vibration. Use the slump specified in [415.3.6](#) for vibratory consolidation. Perform vibratory consolidation after strike-off of the concrete and before the screeding. Strike off concrete consolidated by vibration to a level that ensures that the finishing machine operates properly. Unless the engineer directs otherwise, vibrate a given area of concrete with a single pass of the vibrator, while moving in a forward direction.
- (5) Adjust external type vibrators, if operating, so the entire length of the pan is in contact with the concrete. Operate internal type vibrators submerged at the proper depth to preclude displacing any reinforcement.

415.3.11.2.3 Slip-Formed Pavement

- (1) Maintain continuous operation of the paver if depositing, spreading, consolidating, and finishing. Minimize starting and stopping the paver. Vibrate the concrete, either externally or internally, with sufficient intensity to consolidate it throughout its entire width and depth. Use vibrators conforming to [415.3.1.3](#). If it is necessary to stop the forward movement of the paver, stop vibrating and tamping immediately, and restart when forward motion resumes. Use the slump as specified in [415.3.6](#).

415.3.11.3 Striking-Off and Consolidating By Hand

- (1) Do not strike-off or consolidate concrete by hand without the engineer's permission. Strike-off and screed concrete as soon as placed, to the crown and cross section the plans show, and to an elevation above grade that results in the required grade elevation after consolidating and finishing the pavement surface.
- (2) Consolidate the concrete using internal type spud vibrators.
- (3) Use an engineer-approved screed, of sufficient rigidity to retain its shape, constructed of either metal or other suitable material, and at least 2 feet (600 mm) longer than the slab being struck off. Move the screed forward with a combined longitudinal and transverse shearing motion and without raising either end from the side forms during the striking-off process. Repeat this action, if necessary, until the surface is of uniform texture, true to grade and cross section, and free from porous areas.

- (4) The contractor may use surface type vibratory screeds for hand strike-off and to supplement internal vibration. Do not over vibrate if using the internal spud vibrator and the vibratory screed. If using vibratory screeds, first spread and partially level the concrete with shovels, a straightedge or other means, allow sufficient material above the forms for consolidation, then operate the vibrator with the screed moving forward, sliding on the forms, with a uniform amount of concrete in front of it for the full width of the pour. Maintain a sufficient amount of concrete, during operations, in front of the screed to fill all voids or low areas. Do not allow excessive amounts of concrete to accumulate in front of the screed, causing the concrete to surge under the screed, or produce ridges or waves in the surface. Unless the engineer directs otherwise, do not make more than 2 passes of the vibratory screed on a given area of concrete. Perform the second pass of the screed with a small roll of concrete in front of it to smooth out any irregularities in the surface. Regulate the speed of the forward movement of the screed, and the speed of the vibrator, to produce the best results. Do not vibrate the concrete with the screed in a stationary position. After vibratory screed consolidation, finish the concrete.

415.3.11.4 Float Finishing for Fixed-Formed Pavement

- (1) Perform the float finish after completing finishing machine operations. Use an engineer-approved mechanically operated float, of either longitudinal or transverse type, to float the concrete surface smooth. Finish the pavement to the required cross section, elevation, and surface smoothness, or by hand-operated floats, if the engineer allows.
- (2) If using a mechanical longitudinal float, adjust the screed so that it operates in the plane and cross section of the pavement surface with a small amount of mortar carried ahead of the screed. Operate the machine in its forward movement so the screed in its transverse travel passes over each section of the pavement at least 2 times, or as the engineer directs. Do not operate for a prolonged period over a given area. Stop the machine at apparent low areas and back up slightly, bring fresh concrete from the puddle, spread, consolidate and level with hand tools, then continue operations.
- (3) If using a transverse type mechanical float-finisher, adjust the suspended screeds and float-pans to conform to the required grade and crown of the pavement, and operate to produce a smooth, dense concrete surface, free of waves or porous areas. If using the float-finisher attached to or towed by a finishing machine equipped with engineer-approved screeds, perform float finishing while performing the delayed or last trip of screeding operations as specified in [415.3.11.2](#).
- (4) If the finishing machine obtains a satisfactory surface on minor amounts of concrete pavement, the engineer may not require the use of separate mechanical float finishers.
- (5) If the engineer allows hand methods of float finishing, use longitudinal floats operated from footbridges or long-handled smoothing lutes or floats. Remove high spots, fill depressions with fresh concrete from the puddle, and continue floating operations until producing a satisfactory surface.

415.3.11.5 Straightedging

- (1) Test the slab surface, while the concrete is still plastic, for trueness with a 10-foot (3 m) straightedge. Furnish and use an accurate 10-foot (3 m) straightedge with a handle at least 3 feet (1 m) longer than 1/2 the width of the slab. Place the straightedge at the center of the slab, with the blade parallel to the centerline and pull slowly and uniformly to the edge. Hold the straightedge in successive positions, parallel to the road centerline, in contact with the surface, and go over the whole area from one side of the slab to the other as necessary. Advance along the road in successive stages that do not exceed 1/2 the length of the straightedge. Fill any depressions immediately with freshly mixed concrete, and strike off, consolidate, and refinish the concrete. Also, strike off and refinish all projections.
- (2) Continue straightedge testing and refloating until the entire surface is free from observable deviations or irregularities and the slab is the required grade and contour.
- (3) The contractor may use a tube float to accomplish the testing and floating procedure instead of the above straightedging procedure if it can obtain equivalent results.
- (4) Use only minimal amounts of water, if the engineer allows, for operating the tube float and correcting deficiencies found in straightedging.

415.3.11.6 Final Surface Finish

415.3.11.6.1 General

- (1) Perform the final finish after the straightedging or tube floating, and after all excess moisture disappears, and while it is still possible to produce a uniform striated surface texture.

415.3.11.6.2 Design Speed Less Than 40 MPH

- (1) Unless otherwise specified, provide a final finish with an engineer-approved artificial turf drag. Use a drag made of molded polyethylene with synthetic turf blades approximately 0.85 inches (20 mm) long and containing approximately 7200 individual blades per square foot (77 500 blades per m²). Use a seamless strip of artificial turf approximately full pavement width and of sufficient size that during the finishing operation approximately 2 feet (600 mm) of turf, measured parallel to the pavement centerline, is in contact with the pavement surface. Pull the drag with an engineer-approved device that allows control of the time and rate of texturing. Operate the drag in a longitudinal direction to produce a finish acceptable to the engineer. Weight the drag as necessary to maintain contact with the pavement. Keep each drag clean and free of particles of hardened concrete. Replace the drag as necessary to produce the desired finish.
- (2) If the engineer agrees that it is not practical to apply an artificial turf drag, apply a broom finish to small areas of urban pavement and to concrete driveways and other miscellaneous areas.
- (3) Restore pavement texture damaged by rain by re-dragging the concrete while still plastic.

415.3.11.6.3 Design Speed - 40 MPH and Higher

- (1) Texture and tine freshly placed pavement as soon as it is practical after floating. Texture with an artificial turf drag as specified in 415.3.11.6.2. Tine with a self-propelled tining machine. Complete before tining tears or unduly roughens the concrete.
- (2) Tine with a 10-foot (3.022 m) rake constructed with individual 1/8 inch (3 mm) tines randomly spaced as specified in CMM 8.10. Draw the rake transversely across the full pavement width without overlapping passes. Produce uniformly deep grooves approximately 1/8 to 3/16 inch (3 mm to 5 mm) deep. Provide a finished surface free of defects caused by improper handling of the tining machine.
- (3) For rural pavements, the contractor is encouraged to tine at a 1:6 skew, left side forward. Unskewed transverse tining is also acceptable. The contractor may select either skewed or unskewed tining, but must use that pattern exclusively throughout the project.
- (4) For urban pavements use unskewed transverse tining.
- (5) Where using a tining machine is not practical, randomly tine areas to a similar appearance by hand. Use a rake with individual 1/8 inch (3 mm) tines randomly spaced between 3/8 of an inch (10 mm) and 2 1/4 inches (57 mm).

415.3.11.7 Joint Finishing and Edging

- (1) Lift metal channel caps for prefabricated expansion joints until the top edge is above the pavement surface. Lift the caps only after the concrete is shaped, consolidated, straightedged, and surface finished, and set to preserve the width and shape of the joint without slump of adjacent concrete. Remove excess concrete and float, edge, and finish the surface along each side of the joints. Remove these temporary joint devices without disturbing the adjacent concrete.
- (2) Test construction or expansion joints with a straightedge before the concrete sets, and correct if one side of the joint is higher than the other, or if higher or lower than the adjacent slabs.
- (3) Remove any concrete, mortar, or laitance resulting from paving operations, at construction joints, before it hardens, and clean the joint.
- (4) Edge the slab, expansion joints, and construction joints to a 1/4-inch (6 mm) radius. Provide finished edges of the slab and joints that are smooth and true to line.
- (5) At the beginning of each day's run and at the end of the job, stamp into the pavement, in 2 inch (50 mm) letters, the contractor's name and the year of pavement construction.

415.3.11.8 Surface Testing and Correction

415.3.11.8.1 Ten-Foot Straightedge

- (1) As soon as the concrete hardens sufficiently, test the pavement with a 10-foot (3 m) straightedge or other applicable device. Mark and grind down those areas showing high spots greater than 1/8 inch (3 mm) but not exceeding 1/2 inch (13 mm) in 10 feet (3 m) until the area or spot's elevation no longer shows surface deviations greater than 1/8 inch (3 mm) when retested with the straightedge. If the departure from correct cross section or profile exceeds 1/2 inch in 10 feet (13 mm in 3 m), remove and replace the pavement at no expense to the department.

415.3.11.8.2 (Vacant)

415.3.11.8.3 Pavement Grinding and Removal

- (1) Perform grinding with an engineer-approved device specifically designed for pavement grinding having diamond blades uniformly spaced with at least 50 blades per linear foot (300 mm). Perform additional light grinding as necessary to provide a neat rectangular area of uniform appearance. Perform the grinding parallel with the centerline. Do not use a bush hammer or other impact device.
- (2) Do not remove any area or section, required to be removed under [415.3.11.8.1](#), less than 10 feet (3 m) in length or less than the full width of the lane involved. If it is necessary to remove and replace a section of pavement, also remove and replace remaining portions of the slab adjacent to the joints less than 10 feet (3 m) in length.
- (3) Complete required grinding or replacement before determining the pavement thickness.

415.3.11.8.4 Edge Slump Tolerance

- (1) If constructing pavement by the slip-form method, the engineer will allow an edge slump tolerance of 3/8 inch (10 mm), exclusive of edge rounding, at locations with no adjacent concrete construction; and an edge slump tolerance of 1/8 inch (3 mm), exclusive of edge rounding, at locations with adjacent concrete construction. Correct edge slump in excess of these requirements before the concrete hardens.

415.3.12 Curing Concrete

415.3.12.1 General

- (1) Maintain adequate moisture throughout the concrete mass to support hydration until the concrete develops sufficient strength to open it to service. Cure all concrete by one or a combination of the following methods:
 1. Impervious coating.
 2. Impervious sheeting.
 3. Continuous wet cure.
 4. Alternate method the engineer approves.
- (2) If the contractor does not cure concrete as specified in this subsection, the engineer may suspend concrete placement operations.

415.3.12.2 Impervious Coating Method

- (1) After finishing operations, and as soon as the free water disappears, spray the concrete surface with a uniform coating of curing compound conforming to curing agent requirements specified in [415.2.4](#). Seal moisture in the concrete by applying a continuous water-impermeable film on all exposed concrete surfaces.
- (2) Provide sufficient agitation while spraying to ensure uniform consistency and dispersion of pigment within the curing compound during application.
- (3) Apply the curing compound with an engineer-approved self-propelled mechanical power sprayer whenever practical. The contractor may use hand-operated spraying equipment for the following:
 1. Irregular, narrow, or variable width sections.
 2. Re-coating applications or after form removal.
 3. Special applications the engineer approves.
- (4) For tined surfaces, apply the curing compound uniformly at or exceeding a minimum rate of one gallon per 150 square feet (0.27 L/m²). For all other surface finishes, apply the curing compound uniformly at or exceeding a minimum rate of one gallon per 200 square feet (0.20 L/m²).
- (5) If the curing compound coating is damaged within 72 hours after application, immediately recoat the affected area. If removing forms within 72 hours after placing the concrete, coat newly exposed surfaces within 30 minutes after form removal.

415.3.12.3 Impervious Sheeting Method

- (1) After finishing the concrete and allowing it to harden enough to prevent excessive marring, immediately cover all exposed concrete surfaces with one or a combination of the following impervious sheeting materials:

1. Polyethylene sheeting conforming to [415.2.4](#).
 2. Polyethylene-coated burlap conforming to [415.2.4](#). Pre-wet the polyethylene-coated burlap and place the uncoated side against the concrete.
 3. If the engineer approves, insulated curing blankets with an impervious coating.
 4. Alternate impervious sheeting materials as the engineer approves.
- (2) Provide enough sheeting material to cover all exposed edges, with enough excess to enable use of weights or anchors to hold the material securely in place. Provide 12 inches (300 mm) or more overlap between adjacent pieces of sheeting. Place the sheeting material in direct contact with all exposed concrete surfaces.
 - (3) Maintain the sheeting material in place until the concrete conforms to the opening criteria specified in [415.3.17](#). If temporary removal is required to remove forms or perform other necessary work, re-cover all exposed concrete as quickly as practical, or as the engineer directs.
 - (4) If the engineer approves, the contractor may reuse sheeting materials that are in serviceable condition.

415.3.12.4 Continuous Wet Cure Method

- (1) After finishing the concrete and allowing it to harden enough to prevent excessive marring, immediately spray or fog the exposed surfaces of the concrete to keep it moist until the concrete achieves the opening criteria specified in [415.3.17](#). The contractor may apply a layer of thoroughly wetted burlap to protect the surface from the mechanical impact of the spray.
- (2) If there is evidence the curing water causes concrete surface erosion, the engineer will immediately suspend spraying or fogging. Remedy the conditions causing erosion or switch to another curing method.
- (3) If ambient temperatures are predicted to fall below 40 F (5 C) within the next 24 hours, suspend continuous wet curing and switch to another curing method.

415.3.12.5 Alternate Curing Methods

- (1) If the contractor requests, the engineer may approve the use of alternate materials or curing methods. If the engineer requests, supply technical specifications, test results, or performance records to support the proposed alternative method.

415.3.13 Accelerated Hardening of Concrete

- (1) If placing concrete pavement as specified under 415.3.15 and if the engineer allows, the contractor may add calcium chloride to the mix to accelerate concrete hardening. Do not exceed the manufacturer's recommended maximum dosage. If the engineer requests, provide a written copy of the manufacturer's dosage recommendations.
- (2) Add calcium chloride, in solution, by an engineer-approved procedure to the batch ingredients while placing them in the mixer. Provide sufficient water in the job-mixed solutions to dissolve the calcium chloride completely, and ensure that the solution is of a uniform and known concentration. Reduce the quantity of mixing water by the quantity of solution used. Use positive means, a method by which the quantity added cannot vary appreciably from the target value, to introduce the correct quantity of calcium chloride into the mixer.

415.3.14 Removing Forms

- (1) Do not remove forms from the concrete pavement until it sets for at least 6 hours. The contractor may remove individual sections sooner to allow sawing of transverse joints. Carefully remove the forms in a manner to preclude damaging the pavement. Do not drop or stack forms on pavement less than 7 days old.

415.3.15 Cold Weather Concreting

415.3.15.1 General

- (1) The contractor is responsible for the quality of the concrete placed in cold weather. Take all precautions necessary to prevent freezing of the concrete until it has developed sufficient strength to open it to service. Remove and replace frozen or frost damaged concrete at no expense to the department.
- (2) Unless the engineer issues written permission to continue, suspend concreting operations if a descending air temperature in the shade and away from artificial heat falls below 35 F (2 C). Do not resume concreting operations until an ascending air temperature in the shade and away from artificial heat reaches 30 F (-1 C). The engineer may require the contractor to measure the concrete temperature, at the point of placement, if the ambient air temperature falls below 40 F (5 C). Maintain the temperature of the concrete at or above 50 F (10 C) at the point of placement.

- (3) If necessary to maintain placement temperature, the contractor may heat the water, aggregates, or both. Uniformly heat, with steam or by other means, aggregates that are frozen or contain frost. Accurately control the temperature of the mixing water as it is heated. Do not allow the temperature of either the mixing water or the aggregates to exceed 100 F (38 C) when placed together with the cement in the mixer. Control the temperature of the water and the aggregates so that the temperature of the concrete discharged from the mixer is between 50 F (10 C) and 80 F (27 C) inclusive.
- (4) Do not heat the cement, add salt or chemical admixtures to the concrete mix to prevent freezing, or place concrete on a frozen base or subgrade.

415.3.15.2 Protective Covering

- (1) Arrange to have available a sufficient quantity of material to provide thermal protection for concrete that has yet to conform to the opening criteria specified in [415.3.17](#). The contractor may provide clear, black, or white polyethylene sheeting conforming to the requirements, except for color and reflectance, specified in [415.2.4](#). The engineer may allow other curing materials with suitable water resistance, strength, and insulating properties.
- (2) If the national weather service forecast for the construction area predicts temperatures of less than 17 F (-8 C) within the next 24 hours, arrange to have available a sufficient quantity of straw or hay to protect all concrete that has yet to conform to the opening criteria specified in [415.3.17](#). If the engineer approves, the contractor may use other materials placed to the thickness necessary to provide the same insulating protection as the required thickness of loose, dry straw or hay.
- (3) At any time of the year, if the national weather service forecast for the construction area predicts freezing temperatures within the next 24 hours, or when freezing temperatures actually occur, provide the minimum level of thermal protection specified below for concrete that has yet to conform to the opening criteria specified in [415.3.17](#).

PREDICTED OR ACTUAL AIR TEMPERATURE	MINIMUM EQUIVALENT LEVEL OF PROTECTION
22 to <28 F (-6 to <-2 C)	single layer of polyethylene
17 to <22 F (-8 to <-6 C)	double layer of polyethylene
<17 F (<-8 C)	6" of loose, dry straw or hay between 2 layers of polyethylene

- (4) Place protective material as soon as the concrete is finished and sets sufficiently to prevent excessive surface marring. Maintain the protective material in place until the concrete conforms to the opening criteria specified in [415.3.17](#). If necessary to remove the coverings to saw joints or perform other required work, and if the engineer approves, the contractor may remove the covering for the minimum time required to complete that work.

415.3.16 Protecting Concrete

- (1) Erect and maintain suitable barricades and, if necessary, provide personnel to keep traffic off the newly constructed pavement until it is opened for service. Conform to [104.6](#) for methods of handling and facilitating traffic.
- (2) If it is necessary to provide for traffic across the pavement, construct suitable and substantial crossings to bridge over the concrete at all locations the plans or contract designate, at no expense to the department. Span the concrete pavement without transmitting load to the pavement. Make available the required materials for temporary crossings at the site, before placing the pavement. Construct them, as soon as it is practical, after placing and finishing the pavement. Keep the crossing in service to keep traffic off the pavement for a period specified in [415.3.17](#).
- (3) Instead of the above temporary crossings, leave gaps in the pavement to provide for the passage of traffic, if the engineer allows. Pave these gaps after routing the cross traffic over the contiguous ends of the pavement previously constructed.
- (4) Repair or replace all parts of the pavement damaged by traffic or otherwise damaged before its acceptance, at no expense to the department, in a manner satisfactory to the engineer. Protect the pavement against both public traffic and the traffic caused by employees and agents.
- (5) Furnish materials for protecting the unhardened concrete against rain damage. If rain is imminent, cover the unhardened concrete immediately with paper, plastic film, or other suitable material, and planks or forms placed along slip-formed pavement edges.
- (6) Ensure all ditches and drains provide effective drainage.

415.3.17 Opening to Service

415.3.17.1 General

- (1) Maintain moisture, temperature, and physical protection for concrete until it develops sufficient strength to open it to service. The engineer will use the same criteria to allow opening of non-pavement concrete items to service as are used to allow opening of pavement items to traffic.
- (2) The engineer will allow the contractor to open pavement to construction and public traffic when the concrete attains a verified compressive strength of 3000 pounds per square inch (20.7 MPa). Absent compressive strength information, the engineer may allow the contractor to open pavement after the following minimum times, as adjusted for changes in the ambient air temperature on the project:

APPLICATION	EQUIVALENT CURING DAYS
High early strength concrete	3
General purpose concrete (grades A, A2, and A3)	4
General purpose concrete (grades A-FA and A-IP)	5
General purpose concrete (grades A-S, A-S2, A-IS, and A-T)	7

- (3) The equivalent curing day is based on a daily average ambient temperature of 60 F (16 C). The daily average ambient temperature is the average of the high and low engineer recorded temperatures on the project site for each day. If this daily average ambient temperature falls below 60 F (16 C), accumulate equivalent curing days at a reduced rate. For a daily average ambient temperature of:
 1. 60 F (16 C) or more; accumulate one equivalent curing day per calendar day.
 2. 40 to less than 60 F (4 to <16 C); accumulate 0.6 equivalent curing day per calendar day.
 3. Less than 40 F (<4 C); accumulate 0.3 equivalent curing day per calendar day.
- (4) The contractor may operate concrete saws and profilographs on concrete that does not conform to these opening criteria. If the engineer approves, the contractor may operate other necessary light equipment on concrete that does not conform to these opening criteria. The engineer may suspend or delay operations that injure the surface or otherwise damage the concrete. Clean the surface before allowing traffic of any kind on the pavement.

415.3.17.2 Opening Strength

415.3.17.2.1 General

- (1) Determine opening strength and provide the engineer with the information required to verify that strength by one or a combination of the following methods:
 1. Compressive strength testing of cylinders.
 2. Maturity method.
 3. Compressive strength testing of cores.
- (2) The resulting opening strength, if verified by the engineer, will apply to concrete on the same project conforming to the following criteria:
 1. Of the same mix design as the test location.
 2. Cured under similar or more desirable conditions.
 3. Placed on or before the test location.
- (3) If direct compressive strength test results and maturity data are not available, the engineer may estimate compressive strength based on test results of concrete of the same mix design placed contiguously under similar conditions on the same project.

415.3.17.2.2 Compressive Strength Testing of Cylinders

- (1) Submit the compressive strength test results to the engineer for verification. Compute the opening strength as the average of compressive strength test results for 2 cylinders. If the strength of a cylinder is less than 90 percent of the required strength, the engineer will reject the resulting average. Field cure cylinders under conditions similar to those prevailing for the pavement they represent. Fabricate cylinders according to AASHTO T 23 and test the cylinders according to AASHTO T 22.

415.3.17.2.3 Compressive Strength Testing of Cores

- (1) Submit core test results to the engineer for verification. Determine opening strength from the compressive strength of cores obtained and tested according to AASHTO T 24.

415.3.17.2.4 Maturity Method

- (1) Submit the maturity test results to the engineer for verification. Determine the opening strength from the maturity of the in-place concrete, according to ASTM C 1074; use the temperature-time factor method with a 32 F (0 C) datum temperature. Provide to the engineer a strength/maturity calibration curve based either on laboratory developed strength results or on strength results from test slabs incorporated in the project. Develop a new strength/maturity calibration curve if ever the mix design is changed.

415.3.18 Tolerance in Pavement Thickness

415.3.18.1 General

- (1) Construct to the thickness the plans show. The department will determine pavement thickness based on an acceptance program that considers the results of the following:
 1. Contractor quality control tests.
 2. Validation of contractor quality control test procedures.
 3. Verification tests.
 4. Dispute resolution process.
- (2) The department will use contractor probing of the freshly placed concrete as the primary method for determining thickness. The department will base acceptance and payment on the contractor's quality control tests until shown through the validation, verification, or dispute resolution process that the contractor's test results are in error. The department will record the contractor's required quality control test measurements and make them part of the permanent project record.
- (3) The department will determine areas with deficient thickness by coring.

415.3.18.2 Definitions

- (1) Interpret these terms, used to describe thickness within 415.3.18, as follows:

Conforming Greater than or equal to the plan thickness minus 3/8 inch (10 mm).

Nonconforming Greater than or equal to the plan thickness minus 1 inch (25 mm) but less than the plan thickness minus 3/8 inch (10 mm).

Unacceptable Less than the plan thickness minus 1 inch (25 mm).

Measured thickness The thickness determined as the average of the contractor quality control measurements taken for a pavement unit.

Final thickness The thickness determined after validation, verification, and resolution of disputes for an area of pavement.

415.3.18.3 Pavement Units

- (1) Divide the pavement into basic units 250 feet (80 m) long, measured along the pavement centerline. Treat fractional units less than 250 feet (80 m) but greater than or equal to 100 feet (30 m) long as a whole basic unit. Include fractional units less than 100 feet (30 m) long as a part of a contiguous basic unit.
- (2) The basic unit is one lane wide, measured from the pavement edge to the adjacent longitudinal joint; from one longitudinal joint to the next; or between pavement edges if there is no longitudinal joint.
- (3) Establish special units for areas of fillets, intersections, gaps, ramps, and other special areas not included in basic units.

415.3.18.4 Contractor Quality Control Tests

415.3.18.4.1 General

- (1) Determine the measured thickness of a pavement unit by one of the following methods:
 1. For a basic unit containing no unacceptable areas, the average of the 2 required contractor probings made within that unit.

2. For a special unit containing no unacceptable areas, the average of the available measurements made within that unit as agreed upon by the engineer.
 3. For units containing unacceptable areas, the average thickness of the remaining portion of that unit not defined as unacceptable. Base this determination on adjacent required tests and, if the engineer agrees, include additional measurements the contractor may provide.
- (2) In computing the measured thickness for a unit, consider individual measurements in excess of the plan thickness by more than 1/4 inch (6 mm) as the plan thickness plus 1/4 inch (6 mm).

415.3.18.4.2 Probing Method

- (1) Make 2 probings for each basic unit. Perform both probings at a single longitudinal location selected at random. Perform individual probings at transverse locations as agreed upon by the engineer. The engineer may approve or change probing locations at the engineer's discretion.
- (2) Conduct all probing tests as specified in CMM 13.20.9.

415.3.18.4.3 Alternate Methods

- (1) The contractor may employ an alternate method, agreeable to the engineer, to determine the measured thickness of special units. Measure the depth of a special unit at a minimum of 2 locations as the engineer approves. The department will record contractor measurements and a brief description of the method employed and make them part of the permanent project record.

415.3.18.5 Validating Contractor Quality Control Test Procedures

- (1) The engineer will periodically observe the contractor to ensure that the contractor is testing properly. At the engineer's request, bring the probing assembly to the edge of the pavement for the engineer to validate the accuracy of the contractor's recorded measurements.

415.3.18.6 Verification Tests

- (1) The engineer will use probing to verify the acceptability of pavement thickness and will direct these tests at least once for each 1/2 day of paving. The engineer may increase the verification testing frequency to ensure that the pavement thickness is conforming.
- (2) The engineer will select a longitudinal location at random and designate the transverse positions for 2 probings in each lane of pavement at that location. Perform the probing as specified in CMM 13.20.9. The engineer will be present and observe both the plate placement and probing of the freshly placed concrete.
- (3) The engineer will record the individual measurements and calculate the average thickness for each lane. In computing the average thickness for verification tests, the engineer will record measurements in excess of the plan thickness by more than 1/4 inch (6 mm) as the plan thickness plus 1/4 inch (6 mm). The engineer will provide the results of these tests to the contractor immediately.
- (4) If verification tests indicate conforming thickness, the engineer will accept the final thickness as equal to the contractor's measured thickness for the affected pavement and will not require further action.
- (5) If verification tests indicate nonconforming or unacceptable thickness and the contractor's tests do not, the engineer and the contractor will jointly investigate that discrepancy immediately. If this investigation does not lead to a mutually agreeable explanation of the discrepancy, either the engineer or the contractor may invoke the dispute resolution provisions as specified in 415.3.18.7 to determine the final thickness of the affected pavement.
- (6) If the engineer and the contractor agree that the pavement is unacceptable, the engineer will determine the extent of the unacceptable area as specified in [415.3.18.10](#).

415.3.18.7 Resolving Disputes

- (1) The department will base resolution of a disputed thickness on coring. The engineer will perform dispute resolution coring according to AASHTO T 24 and will evaluate it according to AASHTO T 148. The department and the contractor will share equally costs associated with dispute resolution coring, except costs for filling the holes with concrete or mortar.

415.3.18.8 Conforming Areas

- (1) If the final thickness of a pavement unit is conforming, the engineer will not require more measurements and the department will not adjust pay under [415.5.2](#).

415.3.18.9 Nonconforming Areas

- (1) If the final thickness of a pavement unit is nonconforming, the department will make the pay adjustment for that unit contingent upon the final thickness of the next unit in that lane. If the location for the next required random probing series is within 125 feet (40 m) of the first test location, the contractor may select and document a new random location to provide space for corrective action.
- (2) If the final thickness of the next unit is conforming, the department will not assess any pay adjustments for either unit. If the final thickness of the next unit is nonconforming or unacceptable, the department will adjust the pay for both units. The department will continue pay adjustment for each succeeding unit until the contractor produces a unit with conforming final thickness.

415.3.18.10 Unacceptable Areas

- (1) The pavement is unacceptable if one or more of the following is true:
 1. An individual required contractor probe measurement is unacceptable.
 2. The outcome of an investigation of a discrepancy between contractor and verification test results indicates a unacceptable final thickness.
 3. A dispute resolution core is unacceptable.
- (2) The engineer will take additional measurements by coring the hardened concrete to determine the extent of the unacceptable area. The engineer will take cores at points approximately 20 feet (6 m) in each direction of the unacceptable measurement on a line parallel to the centerline or longitudinal axis of the unit. The engineer will continue coring in each direction until locating a core that is not unacceptable. The engineer will determine the limits of the unacceptable area, at each end, by drawing lines across the unit of pavement midway between the location of the last 2 cores.
- (3) The engineer will perform core testing according to AASHTO T 24 and evaluate the results according to AASHTO T 148. Perform coring, including filling of the holes with concrete or mortar, at no expense to the department.

415.3.19 Concrete Crack Repair

- (1) The engineer will inspect concrete pavement and ancillary concrete for transverse cracking, twice, as follows:
 1. After attaining opening strength as specified in [415.3.17](#) but before opening to construction or public service.
 2. Before opening to public service or before partial acceptance as defined in [105.11.1](#), whichever comes first.
- (2) The engineer will determine if a transverse crack needs repair and the type of repair needed. Repair the cracked concrete as the engineer directs.

415.4 Measurement

- (1) The department will measure the Concrete Pavement bid items by the square yard acceptably completed, measured using the centerline length and the width from outside to outside of completed pavement, but limited to the width the plans show or the engineer directs. The department will include fillets for widened sections, or at drain basins and similar locations, placed monolithic with the pavement. The department will not deduct for fixtures with an area, in the plane of the pavement surface, of one square yard (1 m²) or less.
- (2) The department will measure Concrete Pavement Continuous Reinforcement, composed of steel bars, by the square yard of pavement with reinforcement incorporated and acceptably completed. The department will not deduct the areas for clearances called for adjacent to the edges of the slab or joints.

415.5 Payment

415.5.1 General

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
415.0060 - 0199	Concrete Pavement (inch)	SY
415.1080 - 1199	Concrete Pavement HES (inch)	SY
415.5105	Concrete Pavement Continuous Reinforcement	SY

- (2) Payment for the Concrete Pavement and Concrete Pavement HES bid items is full compensation for preparing the foundation, unless provided otherwise; for furnishing, hauling, preparing, placing, curing,

and protecting the concrete: for jointing and joint materials, dowels, and tie bars, unless provided otherwise; for measuring opening strength including fabricating and testing cylinders, obtaining and testing cores, and evaluating maturity; for measuring pavement thickness, except as specified in [415.3.18.7](#); and for filling all core holes. Payment does not include compensation for furnishing reinforcement.

- (3) Payment for Concrete Pavement Continuous Reinforcement is full compensation for furnishing and installing reinforcement and for coating.

415.5.2 Adjusting Pay for Thickness

- (1) For nonconforming pavement thinner than plan thickness minus 3/8 inch (10 mm) and subject to pay adjustment, as specified in [415.3.18](#), the department will adjust pay under the Nonconforming Thickness Concrete Pavement administrative item as follows:

FOR PAVEMENT WITH A FINAL THICKNESS THINNER THAN PLAN THICKNESS BY:	PERCENT OF THE CONTRACT UNIT PRICE
> 3/8 inch (10 mm) but ≤ 1/2 inch (13 mm)	80
> 1/2 inch (15 mm) but ≤ 3/4 inch (19 mm)	60
> 3/4 inch (19 mm) but ≤ 1 inch (25 mm)	50

- (2) If the department determines that areas of pavement have unacceptable final thickness, as specified in [415.3.18.10](#), the engineer will direct the contractor to either:

1. Remove and replace with concrete pavement of conforming thickness. The department will pay for the unacceptable area at the full contract price.
2. Leave the concrete in place. The department will not pay for the unacceptable area.

415.5.3 Adjusting Pay for Pavement Crack Repairs

- (1) The engineer will allocate responsibility and costs for crack repairs, mobilization for traffic control, and traffic control devices, as specified in CMM 8.16.4.
- (2) Pay adjustment for crack repair costs, based on the total repair area in a single panel, includes mobilization for the repair work; sawing; removing pavement; furnishing and placing all materials including dowel bars; and all incidentals. The department will adjust pay for contiguous repair areas in adjacent panels separately. The engineer will compute the pay adjustment for repair costs as the contract unit price for concrete pavement, multiplied by the appropriate multiplier as follows:

FIXED AMOUNT MULTIPLIER PER PANEL FOR FULL OR PARTIAL REPLACEMENT		
REPAIR AREA in square yards (m ²)	SHARED REIMBURSEMENT MULTIPLIER	TOTAL REIMBURSEMENT MULTIPLIER
18 (15) or greater	60	120
12 (10) to < 18 (15)	54	108
6 (5) to < 12 (10)	48	96
< 6 (5)	42	84

FIXED AMOUNT MULTIPLIER PER PANEL FOR ALTERNATE REPAIRS		
REPAIR TECHNIQUE	SHARED REIMBURSEMENT MULTIPLIER	TOTAL REIMBURSEMENT MULTIPLIER
Retrofit dowels	15	30
Rout and seal	0	0
Seal only	0	0
Do no repair	0	0

- (3) The department will adjust pay for traffic control devices and mobilization for traffic control separately.

SECTION 416 CONCRETE PAVEMENT - APPURTENANT CONSTRUCTION

416.1 Description

- (1) This section describes constructing the following:
 - Concrete pavement approach slabs.
 - Concrete pavement widening strips.
 - Concrete driveways and alleys.
 - Pavement terminal units.
 - Concrete pavement repairs.
 - Concrete pavement gaps for vehicular access.
 - Concrete surface drains.
 - Concrete pavement headers.
- (2) This section also describes furnishing and installing the following:
 - Pavement ties for new concrete pavement abutting existing concrete pavement.
 - Pavement dowel bars for load transfer between existing and new concrete.
- (3) This section also describes diamond grinding the surface of existing concrete pavement.

416.2 Materials

416.2.1 General

- (1) If the plans show or the special provisions require, use high early strength concrete to construct all items listed below that have the prefix HES.

416.2.2 Pavement Terminal Units

- (1) Furnish grade A, A-FA, A-S, A-T, A-IS, A-IP, C, C-S, C-IS, C-FA, or C-IP concrete conforming to [501.2](#). Furnish reinforcement steel conforming to [section 505](#).
- (2) Furnish structural steel wide flange beams and plates conforming to ASTM A 36 M and zinc coated according to ASTM A 123.
- (3) Furnish polystyrene filler material conforming to AASHTO M 230. Furnish expansion material in lengths equal to the width of the pavement lanes, and to the thickness and height the plans show.

416.2.3 Pavement Ties

- (1) Furnish pavement ties as specified for tie bars under [415.2.2](#).

416.2.4 Dowel Bars

- (1) Furnish dowel bars as specified in [415.2.2](#). Furnish epoxy grout as specified in [415.2.6](#).

416.2.5 Concrete Pavement Repair

- (1) Use grade C, C-FA, C-S, C-IS, or C-IP concrete as specified in [section 501](#).

416.2.6 Special High Early Strength Concrete Pavement Repair

416.2.6.1 Composition and Proportioning of Concrete

- (1) For the concrete mixture, use a minimum of 846 pounds (502 kg) of cementitious material per cubic yard (m^3) of concrete. Determine all materials and proportions of the concrete mixture to obtain a minimum compressive strength in the concrete of 3000 pounds per square inch (20.7 MPa) within 8 hours of placement. The contractor may add one or a combination of admixtures to the ingredients or to the mixture in order to obtain the required minimum strength and required air content. Do not retemper the concrete mixture.
- (2) Provide calcium chloride, if used in the mix, either as a pre-mixed solution or as a job-mixed solution. Ensure that job-mixed solutions contain 1.0 pounds per quart (0.48 kg/L) of 77 percent calcium chloride or 0.9 pounds per quart (0.43 kg/L) of 90 percent calcium chloride. Do not exceed the manufacturer's recommended maximum dosage. If the engineer requests, provide a written copy of the manufacturer's dosage recommendations.
- (3) Discharge all concrete within 45 minutes after introducing the mixing water to the cement, or the cement to the aggregates, or within 30 minutes after introducing an accelerating admixture, whichever comes sooner.

- (4) The contractor may use a volumetric mixer conforming to [501.3.6.4](#).

416.2.6.2 Evaluating Strength

- (1) At least 15 calendar days before starting construction provide the engineer with adequate evidence that the required strength is obtainable in the field with the materials used and at the various temperatures encountered. Conduct a continued strength evaluation, if the engineer requires, during the course of the work to ensure continued compliance with the strength requirements.
- (2) Make concrete cylinders under the engineer's supervision. Use an independent testing facility to conduct preliminary and continued strength evaluations. Base each reported value on a minimum of 2 cylinders. After submitting data showing attainment of the required strength, do not change the mix without first submitting a complete new set of test data showing compliance with the requirements.

416.2.7 Concrete Pavement Gaps

- (1) Use concrete of the same proportions as specified for the contiguous pavement. If the engineer allows paving through the gap, use one of the following:
 1. Concrete of the proportions specified for grade E in [501.3.2.2](#) and conforming to all the other requirements for the contiguous pavement.
 2. Grade A or A2 air-entrained high early strength concrete.
 3. Grade C air-entrained concrete.

416.2.8 Concrete Surface Drains

- (1) Use concrete of the same proportions as that in the pavement.

416.2.9 Concrete Headers

- (1) Use concrete of the same proportions as that in the pavement.

416.3 Construction

416.3.1 General

- (1) The engineer will inspect ancillary concrete, as defined in [416.5.2\(1\)](#) and built under section 416, for transverse cracking as specified in [415.3.19](#). Repair cracked concrete as the engineer directs.

416.3.2 Concrete Pavement Approach Slab

- (1) Construct approach slabs as the plans show and conforming to [section 415](#). Unless the engineer directs otherwise, the contractor may construct the approach slab before, at the time of, or after constructing the roadway pavement.
- (2) The contractor may use built-up forms instead of full depth metal side forms. Place reinforcing steel as the plans show. Employ engineer-approved methods to hold and retain the dowel bars in their proper position during concrete placing and finishing.

416.3.3 Concrete Widening

- (1) Construct widening strips as the plans show and conforming to [section 415](#). Construct the surface grade of the widening strips along and adjacent to the existing pavement flush with the average surface of the existing pavement unless otherwise specified or authorized.
- (2) Keep the existing road open to all traffic during construction operations unless the special provisions specify otherwise. Conduct work in a manner that causes the least possible obstruction and inconvenience to traffic. Unless specified otherwise, construct the widening strips on one side of the pavement at a time, and keep the pavement and shoulder opposite the side under construction clear and open to public traffic at all times. Do not deposit or store materials, tools, or equipment on the pavement or shoulders.
- (3) During pavement widening work, handle traffic according to [104.6](#) and as specified otherwise.
- (4) If widening sections uniformly 10 feet (3 m) or more in width, as the plans show or the special provisions specify, and if using fixed-form methods, strike off and consolidate the edge adjacent to the existing pavement to a side form. Accurately set the side form to line and grade, and place it not less than one foot (300 mm) or more than 2 feet (600 mm) from the edge of, and parallel to, the existing pavement. Unless the contract specifies otherwise, remove this inside form as soon as the concrete between the forms is struck off and consolidated. Break down the edge of the fresh concrete and fill in, consolidate,

and hand finish the area between the new concrete and the old pavement. Use extreme care to secure a monolithic section and to ensure the filled section attains the full required thickness. If using slip-form methods, strike off and consolidate the edge adjacent to the existing pavement to the required grade on a line not less than one foot (300 mm) or more than 2 feet (600 mm) from the edge of, and parallel to, the existing pavement. Fill in, consolidate, finish, and slope the area between the old pavement and the new concrete to conform to the old pavement.

- (5) Use machine strike-off and consolidation methods where the widening strip is uniformly 10 feet (3 m) or more in width.
- (6) Only use hand methods for strike-off and consolidation where the widening strip is uniformly less than 10 feet (3 m) in width or for other conditions specified in [415.3.11.3](#).
- (7) Straighten all tie bars in the existing pavement to their effective position.

416.3.4 Concrete Driveways and Concrete Alleys

- (1) Construct concrete driveways and alleys as the plans show and conforming to [section 415](#). The contractor may use wood forms conforming to [415.3.3](#).
- (2) If the plans show longitudinal joints, place construction joints unless specified otherwise. Place an expansion joint where the driveway or alley abuts a pavement or sidewalk.
- (3) The contractor may use hand methods for strike-off and consolidation. If the engineer allows, the contractor may finish the surface, after strike-off and consolidation, using long-handled wood floats, followed by brooming or dragging with an artificial turf drag.

416.3.5 Pavement Terminal Units

- (1) Construct pavement terminal units consisting of reinforced concrete sleeper slabs with structural steel wide flange beams as the plans show. Fabricate and assemble the wide flange beam and plates as the plans show.
- (2) Excavate the trench for the terminal unit to the required width, depth, and length required for forming. Use a method of forming the unit that ensures the slab has vertical sides and conforms to the length, width, and depth the plans show. Steel trowel the surface of the sleeper slab beneath the continuously reinforced pavement.
- (3) Secure the required reinforcing steel in place before placing the concrete. Conform to the curing requirements specified in [415.3.12](#).

416.3.6 Pavement Ties

416.3.6.1 Force Driven

- (1) Drill a suitably sized hole into the edge of the existing concrete pavement to a depth of 7 inches (175 mm) for installing the tie bar. Force drive the tie bar to a depth of 6 inches (150 mm) into the prepared hole as the plans show.

416.3.6.2 Grouted

- (1) Drill holes into the edge of the existing concrete pavement to the dimensions the plan shows.
- (2) Use a quick setting, non-shrinking, high-strength mortar to grout the pavement ties into the drill holes. Clean all drilling dust, debris, and excess moisture out of the drill holes before grouting. Place an ample amount of mortar in the back of the hole and insert the bar so that it is uniformly coated with mortar and all the voids within the drill hole are filled completely. Use a mortar consistency thick enough to prevent excessive flow from the installation.

416.3.7 Dowel Bars

- (1) Drill holes into the edge of the existing concrete pavement to the dimensions the plans show. Anchor the dowel bars into the existing concrete pavement with an epoxy grout conforming to [415.2.6](#).
- (2) Clean drilling dust, debris, and excess moisture from drill holes before inserting the epoxy grout and dowel bar.
- (3) Inject the epoxy grout into the back of the drill hole. Use a grout with a workable viscosity, pumpable, yet thick enough to remain in the hole. Insert a sufficient volume of grout into the hole to provide a small quantity of excess material at the face of the concrete after fully inserting the dowel.

- (4) Insert dowel bars in the drill holes and rotate 1/2 turn. Do not force drive dowel bars into the drill holes.
- (5) Completely fill the annular space between the dowel bar and the concrete with grout. Insert a retaining ring over the bar, and push the ring flush against the concrete surface to retain the epoxy grout.
- (6) Coat the free end of each dowel bar with a thin uniform layer of bond breaking lubricant.
- (7) Use a positive fixed displacement dispensing system, equipped with a nozzle of sufficient length to deposit the epoxy at the back of the drilled hole. Use a system equipped with a means of checking the mix ratio of the epoxy components. Use the manufacturer's recommended mix ratio and check the ratio at least once a day.
- (8) For minor quantities of dowel bars, the contractor may use hand-powered mixing and injecting equipment capable of thoroughly mixing and depositing the epoxy grout at the back of the drill hole.

416.3.8 Concrete Pavement Repair

- (1) Remove concrete pavement as specified under 416.3.9.1.
- (2) Remove asphaltic patch as specified under 416.3.9.2.
- (3) Prepare the foundation as specified under 416.3.9.3.
- (4) Place concrete as specified under 416.3.9.4, except disregard the same-day requirements for completion of curing and opening to traffic.

416.3.9 Special High Early Strength Concrete Pavement Repair

416.3.9.1 Removing Concrete Pavement

- (1) If removing portions of concrete pavement from existing pavement that will remain in place, delineate the line of removal neatly and accurately with a full depth saw cut to facilitate removal without damaging the remaining pavement.
- (2) If the contractor damages the remaining pavement, repair the pavement at no expense to the department. Repair the damaged pavement as specified in the details the plans show for concrete pavement repair. Ensure the width of the damage repair is the same as the adjacent planned repair, or a full lane width if not adjacent to a planned repair.
- (3) Remove concrete with minimal disturbance to the aggregate base. At the close of each day's work, remove all slabs from the roadway. Incorporate or dispose of removed pavement as specified in [203.3.4](#). If removing old slabs and not immediately hauling them from the roadway, store them a minimum of 10 feet (3 m) from the live traffic lane.
- (4) Replace areas of the asphaltic shoulder removed during these pavement removal operations with a commercially produced asphaltic patching material to the elevation of the adjacent shoulder. Before patching, clean, dry, and provide a uniform edge for the area.

416.3.9.2 Removing Asphaltic Patches

- (1) Remove existing asphaltic patches, consisting of asphaltic pavement or surfacing over in-place concrete pavement or aggregate base, to the depth of the new concrete repair. Saw the existing concrete pavement to full depth, and remove pavement to a minimum distance of one foot (300 mm) from each transverse edge of the asphaltic repair.

416.3.9.3 Foundation

- (1) Place the concrete on existing base shaped to the required cross section. Remove concrete rubble and foreign material without disturbing the base.
- (2) Fill low areas or depressions in the base following removal operations with either compacted aggregate base or additional concrete.

416.3.9.4 Placing Concrete

- (1) Place, cure, and open to traffic special high early strength concrete by sunset on the same day removing the old pavement. Place each repair in one continuous, full depth operation. Consolidate the concrete in place using an immersion type vibrator. Finish the surface by screeding twice, floating, and texturing. Operate the screed parallel to the pavement centerline, unless the repair is over 12 feet (3.6 m) in length.
- (2) Make the transverse edges of the finished repair flush with the edges of the existing concrete pavement. Make the longitudinal surface form a straight line from edge to edge with a tolerance of +/- 1/8 inch (3 mm).

- (3) Finish the final surface of the full depth concrete repair using a burlap drag or broom, transverse to the centerline.
- (4) Date each patch with the month and year of construction.

416.3.10 Concrete Pavement Gaps

- (1) Form gaps by constructing a transverse construction joint as specified in [415.3.9.2](#) or, with the engineer's approval, by an alternate method. If the engineer approves, the contractor may pave continuously through the gap.

416.3.11 Continuous Diamond Grinding

- (1) Diamond grind the surface area of the pavement in a longitudinal direction so that 95 percent of any 3 foot by 100 foot (900 mm by 30 m) section of pavement area within a single lane has a grooved or corduroy-type appearance. Make the grooves approximately 1/16 inch (2 mm) from peak to bottom, and uniformly space them a minimum of 50 per linear foot (300 mm).
- (2) Diamond grind adjacent sides of all faulted transverse joints and cracks so that the residual fault is not greater than 1/16 inch (2 mm). Ensure that both sides of cracks and joints show evidence of grinding.
- (3) After grinding, test the pavement surface with a 10-foot (3 m) straightedge or with a profilograph. Mark and correct all areas showing deviation of more than 1/8 inch in 10 feet (3 mm in 3 m) with the straightedge, or 3/8 inch in 25 feet (10 mm in 7.6 m) as determined by the profilograph.
- (4) Provide a uniform transverse slope of the pavement showing no depressions or misalignment of slope greater than 1/8 inch in 36 inches (3 mm in 900 mm) when tested with a straightedge placed perpendicular to the centerline. Straightedge requirements do not apply across longitudinal joints. Maintain positive transverse drainage.
- (5) Reduce faulting of longitudinal joints so residual faulting does not exceed approximately 1/4 inch (6 mm).
- (6) Remove from the roadway solid and liquid residue from grinding by vacuuming. Do not allow residue and water to flow or blow across lanes used by public traffic or to enter any storm sewer, stream, lake, reservoir, or marsh. Dispose of residue and water at an acceptable material disposal site. The contractor may dispose of residue from pavements in rural areas on the roadway, beyond the shoulder edge, as the engineer approves.

416.3.12 Concrete Surface Drains

- (1) Construct concrete surface drains as the plans show and conforming to the curing requirements specified in [415.3.12](#). Finish the drains to the specified cross section in an engineer-approved manner
- (2) Place tie bars and reinforcement as the plans show.
- (3) Do not allow surface drain basins to span a transverse pavement joint.
- (4) Install and maintain temporary surface drains at the locations designated for permanent drains until those permanent surface drains are completed.

416.3.13 Concrete Headers

- (1) Construct concrete headers as the plans show and conforming to the curing requirements specified in [415.3.12](#). Ensure that the upper surface of the header block provides a smooth continuation of the adjacent pavement or a smooth transition from the old to the new pavement.

416.4 Measurement

- (1) The department will measure the Concrete Pavement Approach Slab bid items by the square yard acceptably completed, based on the width and length the plans show or the engineer directs.
- (2) The department will measure the Concrete Pavement Widening, Concrete Driveway, Concrete Alley, and Concrete Pavement Header bid items by the square yard acceptably completed, as specified in [415.4](#) for Concrete Pavement. Under these bid items the department will only measure area outside the specified limits for the pavement, curbs, gutters, combination curb & gutter or other structures.
- (3) The department will measure Pavement Terminal Units, Pavement Ties, Pavement Dowel Bars, and Concrete Pavement Gaps as each individual unit acceptably completed.
- (4) The department will measure the Concrete Pavement Repair bid items by the cubic yard acceptably completed.

- (5) The department will measure Concrete Pavement Continuous Diamond Grinding by the square yard acceptably completed, determined by multiplying the pavement width by the total length ground.
- (6) The department will measure the Concrete Surface Drains bid items by the cubic yard acceptably completed, based on the dimensions the plans show or the engineer directs.
- (7) If the contract does not include a separate specific item for any or all of the miscellaneous concrete items listed above, the department will measure these items as Concrete Pavement, as specified in [415.4](#).

416.5 Payment

416.5.1 General

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
416.0050	Concrete Pavement Approach Slab	SY
416.0055	Concrete Pavement Approach Slab HES	SY
416.0060	Concrete Pavement Widening	SY
416.0065	Concrete Pavement Widening HES	SY
416.0160 - 0199	Concrete Driveway (inch)	SY
416.0260 - 0299	Concrete Driveway HES (inch)	SY
416.0310	Concrete Alley	SY
416.0315	Concrete Alley HES	SY
416.0410	Concrete Pavement Header	SY
416.0415	Concrete Pavement Header HES	SY
416.0505	Pavement Terminal Units	Each
416.0610	Pavement Ties	Each
416.0620	Pavement Dowel Bars	Each
416.0710	Concrete Pavement Repair	CY
416.0715	Concrete Pavement Repair SHES	CY
416.0805	Concrete Pavement Gaps	Each
416.0905	Concrete Pavement Continuous Diamond Grinding	SY
416.1010	Concrete Surface Drains	CY
416.1015	Concrete Surface Drains HES	CY

- (2) If the contract does not include a separate specific item for any or all of the miscellaneous concrete items listed above, the department will pay for these items under the Concrete Pavement bid items as specified in [415.5](#).
- (3) Payment for the Concrete Pavement Approach Slab bid items is full compensation for providing concrete; for reinforcement, tie bars, dowels, joints, and joint materials; for hauling, mixing, placing, finishing, curing, and protecting the concrete; for hauling and placing reinforcement, dowels, tie bars, and joint materials, including fillers; and for preparing the foundation, unless provided otherwise.
- (4) The department will pay for the Concrete Pavement Widening, Concrete Driveway, Concrete Alley, and Concrete Pavement Header bid items as specified in [415.5](#) for Concrete Pavement.
- (5) Payment for Pavement Terminal Units is full compensation for excavating; for finishing, hauling, and placing concrete, reinforcement, the steel beam, cover plates, and screws; for installing the polystyrene filler and bond breaker material; for developing and sealing the groove back of the flange; and for disposing of all excavated and surplus materials.
- (6) Payment for Pavement Ties is full compensation for furnishing all materials, including coating; for drilling holes in existing concrete; and for grouting or driving.
- (7) Payment for Pavement Dowel Bars is full compensation for furnishing all materials, including coating; for drilling holes in existing concrete; and for grouting.
- (8) Payment for Concrete Pavement Gaps is full compensation for furnishing, hauling, and placing all materials used to form the header; and for forming the header. If the contractor obtains permission to pave through the gap, the department will pay the full contract price for each gap eliminated. Payment for furnishing and placing concrete material is included under Concrete Pavement.

- (9) Payment for the Concrete Pavement Repair bid items is full compensation for furnishing, hauling, preparing, placing, curing, and protecting all materials, except pavement ties and dowel bars installed in the existing concrete pavement; for removing and disposing of existing pavements and excavated materials; for repairing asphaltic shoulders; for sawing joints; for preparing the foundation; for backfilling; and for testing concrete cylinders. The department will pay for full depth saw cuts, pavement ties, and dowel bars installed in the existing concrete pavement, exclusive of those necessary to repair damage caused by the contractor, separately.
- (10) Payment for Concrete Pavement Continuous Diamond Grinding is full compensation for the diamond grinding, and for disposing of all waste materials.
- (11) Payment for the Concrete Surface Drains bid items is full compensation for furnishing and placing concrete, reinforcement, and tie bars; and for excavating, backfilling, mixing, finishing, and curing.

416.5.2 Adjusting Pay for Ancillary Concrete Crack Repairs

- (1) The department will adjust pay for crack repairs on ancillary concrete built under section 416. Ancillary concrete includes curb & gutter whether separately or integrally placed, curb, gutter, medians, sidewalks, loading zones, safety islands, steps, widening strips, gaps, driveways, alleys, and headers. The engineer will allocate responsibility and costs for crack repairs, mobilization for traffic control, and traffic control devices, as specified in CMM 8.16.4.
- (2) Pay adjustment for crack repair costs includes mobilization for the repair work; sawing; removals; furnishing and placing all materials including dowel bars and reinforcement; and all incidentals. The engineer will compute the pay adjustment for repair costs as the contract unit price for the item, times the quantity replaced, multiplied by the appropriate multiplier as follows:

COMPUTED AMOUNT MULTIPLIER PER QUANTITY FOR ANCILLARY CONCRETE		
ITEM	SHARED REIMBURSEMENT	TOTAL REIMBURSEMENT
REPLACED	MULTIPLIER	MULTIPLIER
Quantity replaced	6	12

- (3) The department will adjust pay for traffic control devices and mobilization for traffic control separately.

SECTION 450 GENERAL REQUIREMENTS FOR ASPHALTIC PAVEMENTS

450.1 Description

- (1) This section describes requirements common to plant mixed asphaltic bases and pavements. Exceptions and additional requirements are specified in section 451 through section 499.

450.2 Materials

450.2.1 Acronyms and Definitions

- (1) Interpret materials related acronyms used in sections 450 through 499 as follows:

HMA	Hot mix asphalt
JMF	Job mix formula
PG	Performance graded
RAP	Reclaimed asphaltic pavement
SMA	Stone matrix asphalt
VMA	Voids in mineral aggregate

- (2) Interpret materials related definitions used in sections 450 through 499 as follows:

Asphaltic binder	The principal asphaltic binding agent in HMA, including asphalt cement and material added to modify the original asphalt cement properties.
Filler	A finely divided mineral aggregate added to asphaltic mixtures to improve mixture properties.
Leveling layer	Initial layer placed thinner than the minimum required under 460.3.2 .
Lower layer	Any asphaltic pavement layer that will not be exposed to traffic when the pavement structure is complete. A pavement structure may have multiple lower layers.
Upper layer	The asphaltic pavement layer exposed to traffic when the pavement structure is complete. A pavement structure has only one upper layer.

450.2.2 Aggregate Sampling and Testing

- (1) The department and the contractor will sample and test according to the following methods, except as revised with the engineer's approval:

Sampling aggregates.....	AASHTO T 2
Material finer than No. 200 (75 µm) sieve.....	AASHTO T 11
Sieve analysis of aggregates.....	AASHTO T 27
Mechanical analysis of extracted aggregate.....	AASHTO T 30
Sieve analysis of mineral filler.....	AASHTO T 37
Liquid limit of soils.....	AASHTO T 89
Plastic limit of soils.....	AASHTO T 90
Plasticity index of soils.....	AASHTO T 90
Los Angeles abrasion of coarse aggregate.....	AASHTO T 96
Freeze-thaw soundness of coarse aggregate.....	AASHTO T 103
Sodium sulfate soundness of aggregates.....	AASHTO T 104
Extraction of bitumen.....	AASHTO T 164

450.3 Construction

450.3.1 Equipment

450.3.1.1 Batch Plants

450.3.1.1.1 Plant Scales

- (1) Provide beam, springless, dial, or digital scales on weigh boxes and silos. Use scales of a standard make and design accurate to within 0.5 percent of the maximum required load. For each plant, provide at least ten standard 50 pound (22.7 kg) weights accurate to within 0.1 percent. For each scale, provide a suitable cradle or platform for applying test loads
- (2) If using beam scales for aggregate, provide a separate beam for each size of aggregate. Also provide a device that warns when the applied load is within 200 pounds (90 kg) of the required load.

- (3) If using beam scales for asphaltic materials, provide a tare beam and a full capacity beam with a minimum graduation no greater than 2 pounds (1.0 kg). Also provide a device that warns when the applied load is within 20 pounds (9 kg) of the required load.
- (4) If using dial scales, provide a standard make springless scale designed, constructed, and installed to be vibration free. Ensure that all dials are plainly visible to the operator at all times. Equip with adjustable pointers for marking the weight of each material batched.
- (5) If using digital scales, conform to National Bureau of Standards Handbook 44.

450.3.1.1.2 Automatic Batching

- (1) On contracts with 10,000 tons (10 000 Mg) or more, provide automated batch plants. Ensure that the plants' control system can coordinate mixture proportioning, timing, and discharge by the operation of a single control. Also provide an automatic batch weighing, cycling, and monitoring system.
- (2) On contracts with less than 10,000 tons (10 000 Mg), if the contractor elects to use batch plant automatic systems, conform to the requirements here under 450.3.1.1.2. The contractor need not use automatic recordation. If the contractor elects to use automatic recordation, conform to [450.3.1.1.4](#) for truck loads, or [450.3.1.1.3](#) for batch weights.
- (3) Ensure that the system accurately proportions mixture components by weight or volume in the proper order and controls the mixing cycle sequence and timing. Provide interlocks that ensure that the scale is at zero before a batch can start and that the batch is mixed completely before discharge. Do not start subsequent batches before completely discharging the previous batch. Also provide interlocks that ensure that all batch materials are in the mixer before the batch can discharge. Ensure that unauthorized personnel can not alter mix designs and that equipment emits an audible signal if discharging a batch with out-of-tolerance component weights. Ensure that this signal is loud enough to hear throughout the plant area under normal operating conditions.
- (4) Provide adjustable timing devices to control individual component batching and mixing operations. Provide auxiliary interlock cutoff circuits necessary to stop automatic cycling whenever an weighing error exceeding a specified tolerance occurs or when another part of the control system malfunctions.
- (5) Ensure that the batching system automatic control can stop the cycle in the underweight check position and the overweight check position for each material to check tolerance limits.
- (6) Ensure that the scale system is equipped with a device that applies pressure to a scale lever to simulate batching operations for tolerance checks.
- (7) Consistently deliver materials within the full range of batch sizes within the following tolerances:

MATERIAL	PERCENT OF TOTAL MATERIAL BATCH WEIGHT
Coarse aggregate	+ 1.0
Fine aggregate	+ 1.0
Aggregate for use with salvaged or reclaimed pavement materials	+ 1.5
Mineral filler	+ 0.5
Salvaged or reclaimed asphaltic pavement material	+ 1.5
Asphaltic material	+ 0.1
Zero return for aggregate.....	+ 0.5
Zero return for salvaged or reclaimed material	+ 0.5
Zero return for asphaltic material	+ 0.1

- (8) Unless providing separate tolerance controls for batching mineral filler, reduce aggregate tolerances to +/- 0.5 percent for aggregates delivered before the filler.
- (9) Ensure that the total weight of the batch does not vary by more than +/- 2.0 percent of the designated batch weight.
- (10) Ensure that the electrical circuits for the above delivery tolerances of each cutoff interlock are capable of providing the total span for the full allowable tolerance for maximum batch size. Provide tolerance controls that are automatically or manually adjustable to provide spans suitable for less than full-size batches. Ensure that the automatic controls and interlock cutoff circuits are consistently coordinated with the batching scale or meter within an accuracy of 0.2 percent of the scale or meter nominal capacity^[1] throughout the full range of the batch sizes.

^[1] Nominal capacity of a scale is defined as the maximum quantity which the scale or meter can measure.

- (11) If the automatic control or monitoring systems break down, the contractor may operate the plant manually for up to 2 working days.

450.3.1.1.3 Recording Batch Weights

- (1) On contracts involving 10,000 tons (10 000 Mg) or more of asphaltic mixtures, unless the contractor elects to record truck loads as provided in 450.3.1.1.4, produce an automatic digital record for each batch indicating the proportions of each aggregate component, mineral filler, and asphaltic material.
- (2) Provide a digital recorder that can print multiple copies of mixture reports that give the total weight of asphaltic mixture and asphaltic material both per load and per batch. Include weights of the individual aggregates and fillers. Reports need not provide tare weight and may use accumulative weights. Ensure that reported weights are accurate within +/- 1 kg/500 kg. Allow sufficient time for the scale to come to rest before printing each weight.
- (3) The contractor may use mixture storage silos with digital recorder equipped batch plants if the department determines that the storage silo output is coordinated with the recorded batch weights.
- (4) If the recording system breaks down, the contractor may operate the plant without automatic recording for up to 2 working days.

450.3.1.1.4 Recording Truck Loads

- (1) If not using automatic batch recording, install a digital recorder as part of the platform truck or storage silo scales. Ensure that the recorder can produce a printed digital record of at least the gross or net weights of delivery trucks. Provide gross, tare, and net weights as well as date, time, ticket number, project, and mix type; but not all of this data need be on by the printout system. Ensure that scales can not be manually manipulated during the printing process. Provide an interlock to prevent printing until the scales come to rest. Size the scales and recorder to accurately weigh the heaviest loaded trucks or tractor-trailers hauling asphaltic mixture. Ensure that recorded weights are accurate to within 0.1 percent of the nominal capacity of the scale.
- (2) If the digital recorder breaks down, the contractor may manually record weights for up to 2 working days.

450.3.1.2 Asphaltic Mixture Hauling Vehicles

- (1) Provide trucks for hauling asphaltic mixtures with tight, clean, and smooth boxes. The contractor may thinly coat boxes with a release agent chosen from the department's approved products list. Drain excess release agent after coating. Equip each box with a cover big enough to protect the mixture. Do not use trucks that show oil leaks of any magnitude.

450.3.1.3 Transfer Devices

- (1) Ensure that transfer devices have surge bin capacity adequate to pave continuously at a uniform speed. If maintaining uniform and continuous paving, the engineer may allow the contractor to omit the surge bin. Do not use devices that cause vibrations or other motion that adversely affect the finished ride.

450.3.1.4 Pavers

- (1) Ensure that the screed or strike-off assembly produces a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture. Use a screed adjustable for the required crown and cross section of the finished pavement.
- (2) Ensure that pavers are equipped with an activated screed or strike-off assembly and use activation at all times during paving unless the engineer allows otherwise. Do not extend the screed with one or more static extensions totaling more than 12 inches (300 mm) at either screed end, except at the shoulder end for paving shoulders.
- (3) Provide pavers with department-approved automatics that control the elevation and slope of the screed. The department will not require automatic controls when paving entrances, approaches, side road connections, small irregular areas, or if the engineer determines that using automatic controls is not practical. Use both grade and slope controls whenever automatics are required, except the engineer may waive the longitudinal or grade control requirement for the final surface. Ensure that the operator can adjust or vary the slope throughout super elevated curves and transitions. Also ensure that the system allows the sensor to operate on either side of the paver.
- (4) If automatics break down, the contractor may pave under manual control only until the end of that working day.

450.3.1.5 Compaction Equipment

- (1) Ensure all rollers are in good mechanical condition, capable of operating both forwards and backwards, and the operating mechanism allows for starting, stopping, or reversing direction in a smooth manner, without loosening or distorting the surface being rolled.
- (2) Equip all rollers with a drum or tire lubricator. Do not lubricate with petroleum or tar products.

450.3.2 Constructing Asphaltic Mixtures

450.3.2.1 General

- (1) Notify the engineer at least one business day before paving. Unless the contract provides otherwise, keep the road open to all traffic during construction. Prepare the existing foundation for treatment as specified in [section 211](#), unless the contract specifies otherwise.
- (2) Do not place asphaltic mixture when the air temperature approximately 3 feet (1 m) above grade, in shade, and away from artificial heat sources is less than 36 F (2 C). The contractor may place lower layer and base course mixtures at a lower temperature with the engineer's written approval.
- (3) Do not place asphaltic mixture between October 15 and May 1, regardless of temperature, without the engineer's written approval or direction. Do not construe the engineer's non-approval as grounds for extending contract time.
- (4) If the engineer directs or allows placing asphaltic mixtures between October 15 and May 1, either at the contractor's request or to complete the work to the stage the contract requires, perform the work at the contractor's risk. The department will defer final inspection of the HMA paving or asphaltic surfacing work until May. Before final acceptance restore all pavement damage or defects the engineer attributes to temperature or other weather conditions occurring between October 15 and May 1. Repair or replace pavement as the engineer directs.
- (5) If the engineer directs placing asphaltic mixtures between October 15 and May 1 for department convenience, the department will conduct the final inspection and determine acceptance when the contractor completes placement.
- (6) Place asphaltic mixture only on a prepared, firm, and compacted base, foundation layer, or existing pavement substantially surface-dry and free of loose and foreign material. Do not place over frozen subgrade or base, or where the roadbed underlying the foundation or base is temporarily unstable from the effects of frost heaving. Unless the contract provides otherwise, incorporate loose roadbed aggregate as a part of preparing the foundation, in shoulder construction, or dispose of as the engineer approves.

450.3.2.2 Preparing and Storing Mixtures

- (1) Heat and combine aggregate and asphaltic material to produce a mixture within the temperature range the mixture design specifies when discharged from the mixer. Mix until achieving a homogeneous mixture with uniformly coated aggregate. The contractor may store the mixture in silos.

450.3.2.3 Transporting and Delivering Mixtures

- (1) Deliver the mixture to the paver receiving hopper at a temperature within 20 F (11 C) of the temperature the asphaltic material supplier recommends. Cover all loads during inclement weather or when the ambient air temperature falls below 65 F (18 C).
- (2) If depositing asphaltic mixture on the roadway, provide equipment to pick up substantially all of the asphaltic mixture from the roadway and load it directly into the paver receiving hopper. Use either a device integral to the paver or intermediate transfer equipment.

450.3.2.4 Correcting Base

- (1) Before placing asphaltic base or surface courses, correct the existing pavement by filling potholes, sags, and depressions; altering the existing crown; or other corrections the engineer requires. Place asphaltic lower layer mixtures where and as the engineer directs. The contractor may hand place or use blade graders or mechanical spreaders to place mixture used for wedging, leveling layers, or filling holes. Feather the mixture out to become co-planar with adjoining areas and, unless the engineer directs otherwise, compact uniformly as specified in [450.3.2.6.2](#).

450.3.2.5 Spreading and Finishing Mixture

- (1) Place asphaltic mixtures in layers to the typical sections the plans show with self-propelled pavers. Pave at a constant speed, appropriate for the paver and mixture, that ensures uniform spreading and strike-off with a smooth, dense texture and no tearing or segregation. Do not pave faster than the average delivery rate of asphaltic mixture to ensure, as nearly as possible, continuous paving.

- (2) If placing the initial lane of a given layer, sense off a tight string line, a mobile string line, or a traveling straightedge whichever the engineer approves for the specific field conditions. On subsequent lanes of the layer, the contractor may sense off the adjacent lane surface.
- (3) Avoid raking over machine spread and finished material on surface courses to the extent possible to prevent segregation.
- (4) The contractor may spread material by hand in areas not accessible to pavers. Dump material outside the placement area, spread into place with shovels, and shape to the required grade and contour with rakes and lutes. Do not rake material from a pile of dumped material.
- (5) Do not haul over any portion of a placed layer until after the final rolling is complete on that portion.
- (6) Place multi-lane pavement so that each day's placement in all lanes ends at the same station, unless the engineer directs or allows otherwise.

450.3.2.6 Compaction

450.3.2.6.1 General

- (1) Unless the contract specifies otherwise for the particular type of work, compact using the ordinary compaction procedure. After spreading and strike-off and while still hot, compact each layer thoroughly and uniformly by rolling. Roll during daylight hours unless providing artificial light the engineer finds satisfactory. Use the appropriate number of rollers to achieve the specified compaction, surface finish, and smoothness requirements. Ensure that the compacted surface is smooth and true to the established crown and grade.
- (2) Roll the entire surface until achieving the specified compaction and, to the extent that it is practical, eliminating all roller marks. If turning or reversing the roller, or other operations, causes any scuffing or displacement, immediately correct the damage and revise the rolling procedure to prevent further damage. Keep roller wheels moistened to keep mixture from sticking to them. Do not use excess water. Do not disturb the line and grade elevation of edges of the asphaltic pavement or surfacing.
- (4) Along forms, curbs, headers, walls, and at other places not accessible to the roller, compact the mixture thoroughly with hot hand tampers or mechanical tampers giving equivalent compression. On depressed areas, use a trench roller or other engineer-approved equipment.
- (5) Remove and replace, with fresh hot mixture, any material that is loose and broken, mixed with dirt, or is in any way unacceptable. Also remove and replace areas with excess asphaltic material. Compact replaced mixture immediately to conform with the adjacent placement.

450.3.2.6.2 Ordinary Compaction

- (1) Unless the contract specifies otherwise, compact all patching, leveling, and wedging layers of asphaltic pavement or surfacing; all layers of plant mixed asphaltic base and base widening; driveways; and other non-traffic areas until no further appreciable consolidation is visible under the action of the compaction equipment. Use 2 or more rollers per paver if placing more than approximately 165 tons (150 Mg) of mixture per hour.
- (3) The engineer will assess the compacted density using the methods specified for the particular type of work.

450.3.2.7 Applying Tack Coat

- (1) Apply tack coat as specified in [455.3.2](#) to each layer of a plant-mixed asphaltic base or pavement that will be overlaid with asphaltic mixture under the same contract.

450.3.2.8 Jointing

- (1) Place all layers as continuously as possible without joints. Do not roll over an unprotected end of freshly laid mixture unless interrupting placement long enough for the mixture to cool. If interrupting placement, ensure proper bond with the new surface. Form joints by cutting back on the previous run to expose the full depth of the layer. After resuming placement, place the fresh mixture against the joint to form intimate contact and be co-planar with the previously completed work after consolidation.
- (2) If an asphaltic mat adjoins an older high-type asphaltic mat, cut back the old mat on a straight line to form a butt joint for over full depth of the new mat.
- (3) Clean longitudinal and transverse joints coated with dust and, if necessary, paint with hot asphaltic material, a cutback, or emulsified asphalt to ensure a tightly bonded, sealed joint.

450.3.2.9 Surface Requirements

- (1) Test the surface at engineer-selected locations with a 10-foot (3 m) straightedge or other engineer-specified device. Ensure that upper layers show no variation greater than 1/8 inch (3 mm) between any 2 surface contacts. Ensure that lower layers, shoulder surfacing, and surfacing on temporary connections and bypasses show no variation greater than 1/4 inch (6 mm) between any 2 surface contacts.
- (2) Remove and replace or otherwise correct, using engineer-approved methods, all humps or depressions exceeding the specified tolerance. The engineer may allow nonconforming material to remain in place without repair as specified in [105.3](#).

450.3.2.10 Paving Shoulders

- (1) Conform to the other requirements under [450.3.2](#) except, if constructing shoulders separately and the placement width is too narrow to accommodate the required pavers and rollers, the contractor may use engineer-approved alternate spreading and compaction equipment. Alternate equipment must be capable of satisfactorily laying mixture to the required width, thickness, texture, and smoothness.

450.3.3 Maintaining the Work

- (1) Except as provided under [104.6](#), maintain the work during all construction stages until final or partial acceptance. Protect and repair the prepared foundation, tack coat, base, paved traffic lanes, shoulders, and seal coat. Correct all rich or bleeding areas, breaks, raveled spots, or other nonconforming areas in the paved surface.

450.4 Measurement

- (1) The department will measure asphaltic mixtures by the ton of mixed aggregate and asphaltic material incorporated in the work unless the measurement subsection for a particular application specifies otherwise. Provide the engineer with weigh tickets showing the net weight of each load of material delivered. The department or department-authorized testing firms or agencies will test the contractor's truck, storage silo, or plant scales.
- (2) For minor quantities of mixtures and if the engineer approves, the contractor may report batch weights from plant scales as described in [450.3.1.1.1](#), instead of truck or storage silo scale weights.

450.5 Payment

- (1) All costs of furnishing, maintaining, and operating the truck scale or other weighing equipment and furnishing the weigh tickets is incidental to the contract.
- (2) Nonconforming material allowed to remain in place is subject to price adjustment under [105.3.2](#).
- (3) If the engineer directs or allows placing asphaltic mixtures between October 15 and May 1, either at the contractor's request or to complete the work to the stage the contract requires, the contractor shall bear the cost of restoring damage or defects the engineer attributes to temperature or other weather conditions occurring between October 15 and May 1.
- (4) If the engineer directs placing asphaltic mixtures between October 15 and May 1 for department convenience, the department will not assess disincentives for density or ride on pavement the department orders the contractor to place when the temperature, as defined in [450.3.2.1\(2\)](#), is less than 36 F (2 C).

SECTION 455 ASPHALTIC MATERIALS

455.1 Description

- (1) This section describes asphaltic materials including asphaltic binders, cements, cut-back asphalts, emulsified asphalts, and similar products. This section also describes applying tack coat.

455.2 Materials

455.2.1 General

- (1) Furnish asphaltic material conforming to the department's "Combined State Binder Group Certification Method of Acceptance for Asphalt Binders". Do not change the grade of PG materials.

455.2.2 Sampling

455.2.2.1 PG Asphalts

- (1) Sample according to the department's "Combined State Binder Group Certification Method of Acceptance for Asphalt Binders".

455.2.2.2 MC, SC, and Emulsified Asphalts

- (1) Sample asphaltic material at the job site either before or during unloading. Obtain the engineer's approval of sampling methods and have the engineer observe the sampling. If sampling outside established job working hours, arrange for a department representative to be present.
- (2) Obtain a sample from each railroad tank car or tanker truck of material. If sampling from smaller hauling units or from storage tanks, obtain at least one sample for each 10,000 gallons (40 000 L).
- (3) Obtain representative samples according to AASHTO T 40 except as follows:
 - If bleeding through a drain-cock in the transfer line, allow at least 5 minutes between samples.
 - If sampling from a valve installed in the side or end of the delivery vehicle tank, the valve must be between the quarter points of the tank's vertical diameter. Draw off and discard enough material to clear the intake line of material from previous loads before sampling.
- (4) Use only clean, dry sample containers free from cleaning oil or other contamination. Do not contaminate samples. Tightly seal, mark for identification, and submit to the engineer immediately after filling. The department's laboratory will test the material.

455.2.3 Testing

455.2.3.1 PG Asphalts

- (1) Test according to the department's "Combined State Binder Group Certification Method of Acceptance for Asphalt Binders".

455.2.3.2 MC, SC, and Emulsified Asphalts

- (1) Test MC and SC materials according to the following:

TEST	AASHTO	ASTM
Flash point, open tag	T 79	_____
Flash point, Cleveland cup	T 48	D 92
Kinematic viscosity	T 201	D 2170
Distillation	T 78	D 402
Penetration	T 49	D 5
Ductility	T 51	D 113
Solubility in trichloroethylene	T 44	D 2042
Water	T 55	D 95

- (2) Test emulsified asphalts according to AASHTO T 59.

455.2.4 Physical Properties

455.2.4.1 PG Asphalts

- (1) Furnish material conforming to the department's "Combined State Binder Group Certification Method of Acceptance for Asphalt Binders".

455.2.4.2 MC and SC Asphalts

- (1) Furnish material conforming to the following:

Type MC asphalts AASHTO M 82
Type SC asphalts AASHTO M 141

- (2) If sampling at the job site, also conform to kinematic viscosity requirements as follows:

TYPE	GRADE	VISCOSITY (in centistokes at 60 C)	
		MINIMUM	MAXIMUM
MC	30	25	70
MC and SC	70	60	160
MC and SC	250	230	540
MC and SC	800	700	1800
MC and SC	3000	2600	7000

455.2.4.3 Emulsified Asphalts

- (1) Furnish material conforming, before dilution, to the following:

Anionic emulsified asphalts AASHTO M 140
Cationic emulsified asphalts AASHTO M 208
Polymer-modified cationic emulsified asphalts AASHTO M 316

- (2) If diluting emulsified asphalt, mix thoroughly with an equal amount of potable water. If undiluted samples are not available, test the diluted material and modify AASHTO M 140, M 208, or M 316 to reflect properties resulting from dilution of the asphalt.

455.2.5 Tack Coat

- (1) Under the Tack Coat bid item, furnish type MS-2, SS-1, SS-1h, CSS-1, CSS-1h, or modified emulsified asphalt, unless the contract specifies otherwise.

455.3 Construction

455.3.1 General

- (1) Heat asphaltic materials so that the temperature when entering the mixer or at application is within the limits the supplier specifies.

455.3.2 Tack Coat

455.3.2.1 General

- (1) Apply tack coat only when the air temperature is 36 F (2 C) or more and the existing surface is dry and reasonably free of loose dirt, dust, or other foreign matter. Do not apply if weather or surface conditions are unfavorable or before impending rains.
- (2) Use tack material of the type and grade the contract specifies. The contractor may, with the engineer's approval, dilute tack material as allowed under [455.2.4](#). Apply at 0.025 gallons per square yard (1L/10m²), after dilution, unless the contract designates otherwise. Limit application each day to the area the contractor expects to pave during that day.
- (3) Unless the contract specifies otherwise, keep the road open to all traffic during the work. Plan and prosecute tacking operations to adequately provide for traffic without damaging the work.

455.3.2.2 Equipment

455.3.2.2.1 General

- (1) Provide equipment adequate to perform the work and obtain the progress and quality the contract contemplates as specified in [108.7](#). Have all necessary equipment available on the job before beginning tack coat operations.

455.3.2.2.2 Tank Car Heating Equipment

- (1) Heat the tack material by circulating steam through the coils of the tank or use another engineer-approved system. Use equipment designed to heat without burning or overheating any portion of the material. Provide effective and positive control of the heat at all times.

- (2) The department will reject tack material from tank cars without heating coils, or with defective heating coils, unless the contractor uses engineer-approved alternate methods to heat the material without introducing moisture. Do not agitate or heat the tack coat material by directly introducing live steam.

455.3.2.2.3 Tack Distributors

- (1) Provide a tachometer, pressure gauges, and accurate volume measuring devices or a calibrated tank. Also provide a thermometer for measuring the temperature of the tank contents.
- (2) Equip distributors with a pump power unit and full circulation spray bars adjustable laterally and vertically. Provide a heating system that circulates material through the spray bar during the entire heating process. Also provide a hose and spray nozzle to apply tack to areas inaccessible to the spray bar.

455.3.2.3 Preparing the Existing Surface

- (1) Prepare the base or existing surface as specified for preparing the foundation for asphalt surfacing in [section 211](#). Immediately before applying tack material, sweep existing surfaces to remove dust, dirt, or other objectionable material.

455.3.2.4 Heating and Applying Asphaltic Materials

- (1) Obtain the engineer's approval for an appropriate tack coat application temperature. The department will reject overheated or otherwise damaged tack material.
- (2) Place tack in a single application unless the contract or engineer specifies otherwise. Determine the appropriate width for the application based on traffic handling and sequencing of subsequent surface course construction. Distribute uniformly over the surface to be treated.
- (3) Determine an application rate for the existing surface condition required to effectively bond the overlying material. Obtain the engineer's approval for the application rate. Apply within the tolerances specified in 455.3.2.2.3. Correct for under application by applying additional material. If the contractor can not maintain the application rate within tolerances, discontinue operations and make the necessary corrections to personnel or equipment required to remedy the problem.
- (4) Turn outside edges nozzles to spray parallel to the road centerline. Do not operate with any clogged nozzles.
- (5) Protect structures, as the engineer approves, to prevent spatter or marring by tacking operations. Include surfaces of railings, curbs, gutters, and other appurtenances of existing structures. Also protect adjacent concrete pavement that will not be resurfaced with asphaltic pavement or surfacing.

455.3.2.5 Maintaining Tack Coat

- (1) Except as provided under [104.6](#), maintain the tack coat during all construction stages until final or partial acceptance. Protect and repair the existing surface and the tack coat. Correct areas with excess or deficient tack material and any breaks, raveled spots, or other areas where bond might be affected.

455.4 Measurement

455.4.1 General

- (1) The department will not measure nonconforming asphaltic materials unless the engineer allows those materials to remain in place. The department will deduct for material wasted or not actually incorporated in the work.
- (2) The department will measure asphaltic material, liquid asphalts, and similar products in calibrated tank cars, tank trucks, or storage tanks. Calibrate storage tanks and provide the engineer with charts indicating the depth versus liquid volume relationship.
- (3) The department will correct the measured volume to a temperature of 60 F for PG, MC, and SC asphalts as follows:

- If the specific gravity at 60 F is greater than 0.966:

$$V = V1(1.021 - 0.00035T)$$

- If the specific gravity at 60 F is from 0.850 to 0.966 inclusive:

$$V = V1(1.246 - 0.00041T)$$

Where:

V = Volume in gallons at 60 F.

V1 = Volume in gallons at observed temperature, F.

T = Observed temperature, F.

- (4) Calculate the volume correction for emulsified asphalts as follows:

$$V = V1 / (0.985 + 0.00023T)$$

Where:

V = Volume in gallons at 60 F.

V1 = Volume in gallons at observed temperature, F.

T = Observed temperature, F.

455.4.2 Asphaltic Materials Bid Items

- (1) The department will measure the Asphaltic Material bid items, Asphaltic Material Special, and Asphaltic Material Seal Coat by the ton or gallon acceptably completed. The department may measure using one or more of the following:
1. Asphaltic material shipment net weights.
 2. If batch weights are recorded, the weight of asphaltic material in each batch.
 3. If delivery is intermittent or in such minor quantities that measuring net weight is impracticable, the theoretical percentage of asphaltic material in the mixture.
- (2) If the contractor uses salvaged asphaltic pavement material or RAP in a paving mixture, the department will calculate the quantity of asphaltic material from those sources using the following formula:

$$Q = (P)(p)(T)$$

Where:

Q = Quantity of recovered asphaltic material, in tons.

P = Percentage of recovered asphaltic material used in the mix design.

p = Percentage of salvaged asphaltic pavement material and RAP fed into the plant, expressed as a percentage of the total mixture.

T = Total weight of mixture produced under the contract, in tons.

- (3) When conversion to liquid volume is required, the department will convert as follows:

$$V = 239.5 Q$$

Where:

V = Liquid volume of recovered asphaltic material, in gallons.

Q = Quantity of recovered asphaltic material, in tons.

455.4.3 Tack Coat

- (1) The department will measure Tack Coat by the ton or gallon acceptably completed, based on asphaltic material shipment net weights.
- (2) If the contract requires dilution, the department will measure emulsified asphalts after dilution.

455.5 Payment

455.5.1 General

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
455.0100 - 0199	Asphaltic Material (PG grade)	TON
455.0200 - 0299	Asphaltic Material (PG grade)	GAL
455.0300	Asphaltic Material Special	TON
455.0400	Asphaltic Material Special	GAL
455.0500	Asphaltic Material Seal Coat	TON
455.0505	Asphaltic Material Seal Coat	GAL
455.0600	Tack Coat	TON
455.0605	Tack Coat	GAL

455.5.2 Asphaltic Materials Bid Items

- (1) Payment for the Asphaltic Material bid items, Asphaltic Material Special, and Asphaltic Material Seal Coat is full compensation for providing the asphaltic material, including recovered asphaltic material as calculated under [455.4.2](#); and for transporting, heating, and placing in the mixer.
- (2) The department will pay for nonconforming material the engineer allows to remain in place at 75 percent of the contract unit price.
- (3) The department will administer pay reduction for nonconforming QMP mixture under the Nonconforming QMP Asphaltic Material administrative item. The department will reduce pay based on the contract unit price for the Asphaltic Material bid items used in HMA pavement subject to the QMP adjustments as specified in [460.2.8.2.1.7](#).
- (4) The department will administer disincentives for density under the Disincentive Density Asphaltic Material administrative item. The department will reduce pay based on the contract unit price for the Asphaltic Material bid items used in HMA pavement subject to the density disincentive as specified in [460.5.2.2](#).

455.5.3 Tack Coat

- (1) Payment for Tack Coat is full compensation for providing tack coat; for preparing the existing surface; for transporting and heating; for diluting with water; and for maintaining the completed work. The department will not pay for asphaltic materials applied in excess of the engineer-approved rate plus the tolerance allowed under [455.3.2.2.3](#).
- (2) The department will adjust pay for Tack Coat based on whichever one of the following yields the lowest contractor compensation:
 1. The department will pay for nonconforming material the engineer allows to remain in place at 75 percent of the contract unit price.
 2. The department will pay for excessively diluted tack coat, material diluted with a greater amount of water than specified under [455.2.4.3](#), as follows:

AMOUNT OF WATER ^[1] (percent of diluted asphaltic material)	PERCENT OF THE CONTRACT PRICE
<= 60	100
> 60 but <= 80	50
> 80	0

^[1] Does not include water used to produce the emulsified asphalt.

SECTION 460 HOT MIX ASPHALT PAVEMENT

460.1 Description

- (1) This section describes HMA mixture design, providing and maintaining a quality management program for HMA mixtures, and constructing HMA pavement.

460.2 Materials

460.2.1 General

- (1) Furnish a homogeneous mixture of coarse aggregate, fine aggregate, mineral filler if required, SMA stabilizer if required, and asphaltic material.

460.2.2 Aggregates

460.2.2.1 General

- (1) Furnish an aggregate blend consisting of hard durable particles containing no more than a combined total of one percent, by weight, of lumps of clay, loam, shale, soft particles, organic matter, adherent coatings, and other deleterious material. Ensure that the aggregate blend conforms to the percent fractured faces and thin or elongated requirements of table 460-2. If the aggregate blend contains materials from different deposits or sources, ensure that material from each deposit or source has a LA wear percent loss meeting the requirements of table 460-2.
- (2) If the department requests, submit samples representative of the aggregate proposed for the work. Minimum sampling frequencies are specified in the department's test method number 1559. Have an HTCP certified technician sample the aggregate. Deliver samples to the laboratory at least 14 days before using in the work. Obtain the engineer's approval of the aggregates before producing HMA mixtures.

460.2.2.2 Freeze-Thaw Soundness

- (1) The department will conduct freeze/thaw soundness tests, on the fraction retained on the No. 4 (4.75 mm) sieve, for virgin crushed stone aggregates produced from limestone/dolomite sources in one or more of the following counties or from out of state:

Brown	Columbia	Crawford	Dane	Dodge
Fond du Lac	Grant	Green	Green Lake	Iowa
Jefferson	Lafayette	Marinette	Oconto	Outagamie
Rock	Shawano	Walworth	Winnebago	

- (2) The department may waive freeze/thaw testing for existing quarries determined to be in either the Silurian system or the Prairie du Chien group of the Ordovician system of rocks.
- (3) If the aggregate blend contains materials from different deposits or sources, ensure that material from each deposit or source has a freeze-thaw loss percentage meeting the requirements of table 460-2.

460.2.2.3 Aggregate Gradation Master Range

- (1) Ensure that the aggregate blend, including RAP and mineral filler, conforms to the gradation requirements in table 460-1. The values listed are design limits; production values may exceed those limits.

TABLE 460-1 AGGREGATE GRADATION MASTER RANGE AND VMA REQUIREMENTS

SIEVE SIZE	PERCENTS PASSING DESIGNATED SIEVES						
	NOMINAL SIZE						
	37.5 mm	25.0 mm	19.0 mm	12.5 mm	9.5 mm	SMA 12.5 mm	SMA 9.5 mm
50.0 mm	100						
37.5 mm	90 – 100	100					
25.0 mm	90 max	90 - 100	100				
19.0 mm	—	90 max	90 - 100	100		100	
12.5 mm	—	—	90 max	90 - 100	100	90 - 97	100
9.5 mm	—	—	—	90 max	90 - 100	58 - 72	90 - 100
4.75 mm	—	—	—	—	90 max	25 - 35	35 - 45
2.36 mm	15 – 41	19 - 45	23 - 49	28 - 58	20 - 65	15 - 25	18 - 28
75 µm	0 – 6.0	1.0 - 7.0	2.0 - 8.0	2.0 - 10.0	2.0 - 10.0	8.0 - 12.0	10.0 - 14
PERCENT MINIMUM VMA	11.0	12.0	13.0	14.0	15.0	15.5	16.5

- (2) Unless the contract designates otherwise, ensure that the nominal size of the aggregate used in the mixture conforms to the following:

PAVEMENT LAYER	NOMINAL SIZE
Lower layer pavement	19.0 mm
Upper layer pavement	12.5 mm
Stone matrix layer pavement	12.5 mm

460.2.3 Asphaltic Binders

- (1) The department will designate the grade of asphaltic binder in the contract. The contractor may use virgin binder, modified binder, a blend of virgin and recovered binder, or a blend of modified and recovered binder. Ensure that the resultant asphaltic binder conforms to the contract specifications.

460.2.4 Additives

460.2.4.1 Hydrated Lime Antistripping Agent

- (1) If used in HMA mixtures, furnish hydrated lime conforming to ASTM C 977 and containing no more than 8 percent unhydrated oxides. Add one percent or more, by weight of the total dry aggregate. Do not begin production until the engineer approves the lime introduction and mixing methods.

460.2.4.2 Liquid Antistripping Agent

- (1) If used in HMA mixtures, add liquid antistripping agent to the asphaltic binder before introducing the binder into the mixture. Ensure that addition of liquid antistripping agent does not alter the characteristics of the original asphaltic binder beyond the following limits:
1. A viscosity change of more than +/-400 poises.
 2. A penetration change of more than -4 or +10.

460.2.4.3 Stone Matrix Asphalt Stabilizer

- (1) Add an organic fiber, an inorganic fiber, a polymer-plastic, a polymer-elastomer, or approved alternate stabilizer to all SMA mixtures. If proposing an alternate, submit the proposed additive system, asphaltic binder and stabilizer additive, along with samples of the other mixture materials to the department at least 14 days before the project let date. The department will approve or reject that proposed alternate additive system no later than 48 hours before the project let date.
- (2) Use a single additive system for all SMA pavement in the contract.

460.2.5 Reclaimed Asphaltic Pavement Materials

- (1) The contractor may use up to 35 percent RAP material in lower layer and base mixtures and up to 20 percent in upper layer mixtures. Ensure that the combined RAP and virgin aggregate conforms to aggregate requirements of table 460-2.

460.2.6 Recovered Asphaltic Binders

- (1) Establish the percent of recovered asphaltic binder from RAP for the mixture design according to AASHTO T 164 using the appropriate dust correction procedure. If test results indicate a change in the percent of recovered asphaltic binder from RAP, the contractor or the engineer may request a change in the design recovered asphaltic binder from RAP. Accompany that request with at least 2 recent RAP extractions from the contractor's mixture design laboratory supporting that change.
- (2) The contractor may use up to 25 percent RAP for lower layers and up to 20 percent RAP for upper layers without changing the asphaltic binder grade. If using more than that amount of RAP, furnish binder with a low temperature rating one grade lower than the contract designates, unless testing indicates the resultant binder meets the grade the contract originally specified.

460.2.7 HMA Mixture Design

- (1) For each HMA mixture type used under the contract, develop and submit an asphaltic mixture design according to the department's test method number 1559 and conforming to the requirements of table 460-1 and table 460-2. The department will review mixture designs and report the results of that review to the designer according to the department's test method number 1559.

TABLE 460-2 MIXTURE REQUIREMENTS

Mixture type	E - 0.3	E - 1	E - 3	E - 10	E - 30	E - 30x	SMA
ESALs x 10 ⁶ (20 yr design life)	< 0.3	0.3 - < 1	1 - < 3	3 - < 10	10 - < 30	≥ 30	—
LA Wear (AASHTO T 96)							
100 revolutions(max % loss)	13	13	13	13	13	13	13
500 revolutions(max % loss)	50	50	45	45	45	45	45
Soundness (AASHTO T 104) (sodium sulfate, max % loss)	12	12	12	12	12	12	12
Freeze/Thaw (AASHTO T 103) (specified counties, max % loss)	18	18	18	18	18	18	18
Fractured Faces (ASTM 5821) (one face/2 face, % by count)	60 / —	65 / —	75 / 60	85 / 80	98 / 90	100/100	100/90
Thin or Elongated (ASTM D4791) (max %, by weight)	5 (5:1 ratio)	5 (5:1 ratio)	5 (5:1 ratio)	5 (5:1 ratio)	5 (5:1 ratio)	5 (5:1 ratio)	20 (3:1ratio)
Fine Aggregate Angularity (AASHTO T304, method A, min)	40	40	43	45	45	45	45
Sand Equivalency (AASHTO T 176, min)	40	40	40	45	45	50	50
Gyratory Compaction							
Gyrations for N _{ini}	6	7	7	8	8	9	8
Gyrations for N _{des}	40	60	75	100	100	125	100
Gyrations for N _{max}	60	75	115	160	160	205	160
Air Voids, %V _a (%G _{mm} @ N _{des})	4.0 (96.0)	4.0 (96.0)	4.0 (96.0)	4.0 (96.0)	4.0 (96.0)	4.0 (96.0)	4.0 (96.0)
% G _{mm} @ N _{ini}	< 91.5 ^[1]	< 90.5 ^[1]	< 89.0 ^[1]	< 89.0	< 89.0	< 89.0	—
% G _{mm} @ N _{max}	≤ 98.0	≤ 98.0	≤ 98.0	≤ 98.0	≤ 98.0	≤ 98.0	—
Dust to Binder Ratio ^[2] (% passing 0.075/P _{be})	0.6 - 1.2	0.6 - 1.2	0.6 - 1.2	0.6 - 1.2	0.6 - 1.2	0.6 - 1.2	1.2 - 2.0
Voids filled with Binder (VFB or VFA, %)	70 - 80 [4] [5]	65 - 78 [4]	65 - 75 [4]	65 - 75 [3] [4]	65 - 75 [3] [4]	65 - 75 [3] [4]	70 - 80
Tensile Strength Ratio (TSR) (ASTM 4867)							
no antistripping additive	0.70	0.70	0.70	0.70	0.70	0.70	0.70
with antistripping additive	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Draindown at Production Temperature (%)	—	—	—	—	—	—	0.30

^[1] The percent maximum density at initial compaction is only a guideline.

^[2] For a gradation that passes below the boundaries of the caution zone(ref. AASHTO MP3), the dust to binder ratio limits are 0.6 - 1.6.

^[3] For 9.5mm nominal maximum size mixtures, the specified VFB range is 73 - 76%.

^[4] For 37.5mm nominal maximum size mixes, the specified VFB lower limit is 67%.

^[5] For 25.0mm nominal maximum size mixes, the specified VFB lower limit is 67%.

460.2.8 Quality Management Program

460.2.8.1. General

- (1) Provide and maintain a QC program defined as all activities, including mix design, process control inspection, sampling and testing, and process adjustments related to producing and placing HMA pavement conforming to the specifications. The contractor may also provide an optional CA program.
- (2) The department will provide product quality verification as follows:
 1. By conducting verification testing of independent samples.
 2. By periodically observing contractor sampling and testing.
 3. By monitoring required control charts exhibiting test results and control parameters.
 4. By the engineer directing the contractor to take additional samples at any time during production.
- (3) Refer to section 5 of the department's QMP guide/procedure manual for detailed guidance on sampling, testing, and documentation under the QMP.

460.2.8.2 Contractor Testing

460.2.8.2.1 Required Quality Control Program

460.2.8.2.1.1 Personnel Requirements

- (1) Provide HTCP certified sampling and testing personnel. Provide at least one full-time HMA technician certified at level I or higher at each plant site furnishing material to the project. Before mixture production begins, post an organizational chart in the contractor's laboratory. Include the names, telephone numbers, and current certifications of all personnel with QC or CA responsibilities. Keep the chart updated.
- (2) Ensure that sampling personnel are qualified as follows^[1]:
 - HMA technician certified at level I or higher.
 - HMA ACT.

^[1] After informing the engineer, an uncertified person under the direct observation of an HMA technician certified at level I or higher may sample for a period not to exceed 3 calendar days.

- (3) Ensure that all testing, data analysis, and data posting personnel are qualified as follows:
 - HMA technician certified at level I or higher.
 - HMA ACT under the direct supervision of an HMA technician certified at level I or higher.
- (4) Have an HMA technician certified at level II or higher available to make necessary process adjustments.

460.2.8.2.1.2 Laboratory Requirements

- (1) Conduct QC testing in a facility conforming to the department's laboratory qualification program.
- (2) Ensure that the laboratory has at least 320 square feet (30 m²) of workspace and has a telephone for exclusive use by QMP personnel. Also provide a fax machine and copy machine that the contractor or the engineer can use at the plant site. Ensure that all testing equipment conforms to the equipment specifications applicable to the required testing methods.

460.2.8.2.1.3 Required Sampling and Testing

460.2.8.2.1.3.1 Contracts with 5000 Tons of Mixture or Greater

- (1) Furnish and maintain a laboratory at the plant site fully equipped for performing contractor QC testing. Have the laboratory on-site and operational before beginning mixture production.
- (2) Obtain random samples and perform tests according to section 5 of the department's quality management program, guide/procedure manual. Obtain HMA mixture samples from trucks at the plant. Perform tests the same day taking the sample.
- (3) Retain the split portion of the contractor HMA mixture and blended aggregate samples for 14 calendar days at the laboratory site in a dry, protected area. The engineer may decrease this 14-day retention period. At project completion the contractor may dispose of remaining samples if the engineer approves.
- (4) Use the test methods identified below, or other methods the engineer approves, to perform the following tests at a frequency greater than or equal to that indicated:

Blended aggregate according to AASHTO T11 and T27:

Drum plants:

- Field extraction by department test method number 1560.
- Belt samples, optional for virgin mixtures, obtained from stopped belt or from the belt discharge using an engineer-approved sampling device.

Batch plants:

- Field extraction by department test method number 1560.

Asphalt content (AC) in percent:

AC by calculation.

AC by nuclear gauge reading, optional.

AC by inventory, optional.

Bulk specific gravity of the compacted mixture according to AASHTO T166.

Maximum specific gravity according to AASHTO T 209.

Air voids (Va) by calculation according to AASHTO T 269.

VMA by calculation according to AASHTO PP 28.

- (5) Test each design mixture at a frequency at or above the following:

TOTAL DAILY PLANT PRODUCTION
FOR DEPARTMENT CONTRACTS

in tons (Mg)

50 to 600 (45-550)

601 to 1500 (551 – 1360)

1501 to 2700 (1361 – 2450)

2701 to 4200 (2451 – 3810)

greater than 4200 (3810)

SAMPLES

PER DAY^[1]

1

2

3

4

see footnote^[2]

^[1] Frequencies are for planned production. If production is less than planned, base the number of samples on actual production. If production is more than planned, continue sampling using that day's previously established increment. Conform to section 5 of the department's QMP guide/procedure manual.

^[2] Add a sample for each additional 1500 tons (1360 Mg) or fraction of 1500 tons (1360 Mg).

- (6) Also conduct the following tests on the first day of production and once for every eight production samples thereafter, with a minimum of one test per production week.

- Aggregate stockpile gradations sampled from cold feed bins or stockpile according to AASHTO T 11 and T 27.
- Reclaimed or salvaged asphaltic pavement extractions sampled from the cold feed bin or stockpile according to AASHTO T 164 and T 30. The contractor may optionally perform a field extraction according to department test method number 1560.

- (7) The department will waive stockpile testing of the aggregate and reclaimed or salvaged asphaltic pavement if the contractor provides data from tests conducted during stockpile production. Ensure that testing and documentation conforms to section 5 of the department's quality management, guide/procedure manual.

- (8) Also conduct field tensile strength ratio tests according to ASTM D 4867 on all mixtures containing an antistripping additive. Test each full 50,000 ton (46 000 Mg) production increment, or fraction of an increment, in the first week of production of that increment. If field tensile strength ratio values are either below the specification limit or less than the mixture design value by 20 or more, notify the engineer. The engineer and contractor will jointly determine a corrective action.

460.2.8.2.1.3.2 Contracts with Less Than 5000 Tons of Mixture

- (1) Conform to [460.2.8.2.1.3.1](#) modified as follows:

- The contractor may conduct QC tests in an off-site laboratory.
- No field tensile strength ratio testing is required.

460.2.8.2.1.3.3 Contracts with Less Than 500 Tons of Mixture

- (1) The engineer may waive all testing on contracts with less than 500 tons (460 Mg) of mixture.

460.2.8.2.1.3.4 Temporary Pavements

- (1) The engineer may waive all testing for temporary pavements, defined as pavements that will be placed and removed before contract completion.

460.2.8.2.1.4 Documentation

460.2.8.2.1.4.1 Records

- (1) Document all observations, inspection records, mixture adjustments, and test results daily. Note observations and inspection records in a permanent field record as they occur. Indicate all process adjustments and JMF changes on the air void control chart. Submit copies of the running average calculation sheet for blended aggregate, mixture, and asphalt content along with the air void chart and adjustment records to the engineer each day. Submit original testing records and control charts to the engineer in a neat and orderly manner within 10 days after paving is completed.
- (2) Continue charts, records, and testing frequencies, for a mixture produced at one plant site, from contract to contract.

460.2.8.2.1.4.2 Control Charts

- (1) Maintain standardized control charts at the laboratory. Record contractor test results on the charts the same day as testing. Post CA test results on the charts as data becomes available. Record data on the standardized control charts as follows:
 - Blended aggregate gradation tests in percent passing. Of the following, plot those sieves the design specifications require: 37.5 mm, 25.0 mm, 19.0 mm, 12.5 mm, 9.5 mm, 2.36 mm, and 75 μ m.
 - Asphalt material content in percent.
 - Bulk specific gravity of the compacted mixture.
 - Maximum specific gravity of the mixture.
 - Air voids in percent.
 - VMA in percent.
- (2) Plot both the individual test point and the running average of the last 4 data points on each chart. Show QC data in black with the running average in red and CA data in blue. Draw the warning limits with a dashed green line and the JMF limits with a dashed red line. The contractor may use computer generated black-and-white printouts with a legend that clearly identifies the specified color coded components.

460.2.8.2.1.5 Control Limits

- (1) Conform to the following control limits for the JMF and warning limits based on a running average of the last 4 data points:

ITEM	JMF LIMITS	WARNING LIMITS
Percent passing given sieve:		
37.5 mm	+/- 6.0	+/- 4.5
25.0 mm	+/- 6.0	+/- 4.5
19.0 mm	+/- 5.5	+/- 4.0
12.5 mm	+/- 5.5	+/- 4.0
9.5 mm	+/- 5.5	+/- 4.0
2.36 mm	+/- 5.0	+/- 4.0
75 μ m	+/- 2.0	+/- 1.5
Asphaltic content in percent	+/- 0.4	+/- 0.3
Air voids in percent	+/- 1.3	+/- 1.0
VMA in percent	- 1.5	- 1.2

- (2) Warning bands are defined as the area between the JMF limits and the warning limits.

460.2.8.2.1.6 Job Mix Formula Adjustment

- (1) The contractor may request adjustment of the JMF according to the department's test method number 1559. Have an HMA technician certified at level II submit a written JMF adjustment request. Ensure that the resulting JMF is within specified master gradation bands. The department will have an HMA technician certified at level III review the proposed adjustment and, if acceptable, issue a revised JMF. The department will not allow adjustments exceeding specified JMF tolerance limits. Have an HMA technician certified at level II make related process adjustments.

- (2) If mixture redesign is necessary, submit a new JMF, subject to the same specification requirements as the original JMF. Do not reduce the JMF asphalt content unless the production VMA meets or exceeds the minimum VMA design requirement for the mixture produced.

460.2.8.2.1.7 Corrective Action

- (1) When running average values trend toward the warning limits, consider taking corrective action. Document all corrective actions undertaken. Include all test results in the contract files and in running average calculations.
- (2) Notify the engineer if running average values exceed the warning limits. If two consecutive running average values exceed the warning limits, stop production and make adjustments. Do not restart production until after notifying the engineer of the adjustments made. Do not calculate a new running average until the fourth test after the required production stop.
- (3) If the process adjustment improves the property in question so that the running average after 4 additional tests is within the warning limits, the contractor may continue production with no reduction in payment
- (4) If the adjustment does not improve the properties and the running average after 4 additional tests stays inside the warning bands, the mixture is nonconforming and subject to pay adjustment.
- (5) If the contractor fails to stop production and make adjustments when required, all mixture produced from the stop point to the point when the running average is back inside the warning limits is nonconforming and subject to pay adjustment.
- (6) The department will reduce payment for nonconforming QMP HMA mixtures, starting from the stop point to the point when the running average is back inside the warning limits, as follows:

PAYMENT FOR MIXTURE^[1]		
ITEM	PRODUCED WITHIN WARNING BANDS	PRODUCED OUTSIDE JMF LIMITS
Gradation	90%	75%
Asphalt Content	85%	75%
Air Voids	70%	50%
VMA	90%	75%

^[1] Payment is in percent of the contract unit price for both the HMA Pavement and Asphaltic Material bid items. The department will reduce pay based on the nonconforming property with lowest percent pay. The asphaltic material quantity is based on the JMF asphalt content. The department will administer pay reduction under the Nonconforming QMP Asphaltic Material and the Nonconforming QMP HMA Mixture administrative items.

- (7) If the running average values exceed the JMF limits, stop production and make adjustments. Do not restart production until after notifying the engineer of the adjustments made. Continue calculating the running average after the production stop.
- (8) If the air voids running average of 4 exceeds the JMF limits, the material is nonconforming. Remove and replace unacceptable material at no additional expense to the department. The engineer will determine the quantity of material to replace based on the testing data using the methods in section 5 of the department's QMP guide/procedure manual and an inspection of the completed pavement. If the engineer allows the mixture to remain in place, the department will pay for the mixture and asphaltic material at 50 percent of the contract price.
- (9) If the running average of 4 exceeds the JMF limits for other properties, the department will pay 75 percent of the contract price for mixture and asphaltic material if the engineer allows the mixture to remain in place. The engineer will determine the quantity of material subject to pay reduction based on the testing data and an inspection of the completed pavement.
- (10) The department may also apply pay adjustments, as specified in 460.2.8.2.1.7(6) through (9), for special circumstances as follows:
 1. For plants where the total season production of a mixture requires less than 4 tests, the department will assess the material by comparing single data points to 1.5 times the warning and JMF limits.
 2. At contract completion, the department will assess the material by evaluating the last 3 tests as single tests and comparing to 1.5 times the warning and JMF limits.
 3. If the contractor's test results prove incorrect.

460.2.8.2.2 Optional Contractor Assurance

460.2.8.2.2.1 General

- (1) CA testing is optional and is conducted to further validate production testing. The contractor may offer CA data to provide an additional piece of information for the following:
 1. Process control decisions.
 2. Troubleshooting possible sampling, splitting, or equipment problems.
 3. Limiting liability, as defined in section 5 of the department's QMP guide/procedure manual, for nonconforming product as a result of department verification testing. These provisions do not supercede department's rights under [107.16](#).

460.2.8.2.2.2 Personnel Requirements

- (1) Ensure that an HMA technician certified under HTCP at level I or higher performs all CA testing and data analysis. Personnel performing CA testing can not perform QC testing for the same materials.

460.2.8.2.2.3 Laboratory Requirements

- (1) Conduct CA testing in a facility conforming to the department's laboratory qualification program. Furnish and maintain a laboratory fully equipped for performing selected CA tests. If the a single laboratory is providing CA and QC data for the same materials, ensure that a separate set of equipment is used to prepare CA samples and run CA tests.

460.2.8.2.2.4 Testing

- (1) For the CA program, use the test methods enumerated here in 460.2.8.2.2.4, other engineer-approved methods, or other methods the industry and department HMA technical team recognizes. The contractor may select tests at its option. If using tests in limiting liability, as provided in section 5 of the department's QMP guide/procedure manual, data must exist for the property in question.
- (2) Perform selected testing as follows:
 - Bulk specific gravity (Gmb) of the compacted mixture according to AASHTO T 166 based on the average of 2 specimens.
 - Maximum specific gravity (Gmm) according to AASHTO T 209.
 - Air voids (Va) by calculation according to AASHTO T 269.
 - VMA by calculation according to AASHTO PP 28.
 - Stockpile gradation according to AASHTO T 11 and T 27^[1].
 - Blended aggregate gradation on plant mix according to department test method number 1560.
 - Fine aggregate angularity (FAA) according to AASHTO T 304, method A.

^[1] As modified in CMM 13.

- (3) There is no specified frequency for CA testing.
- (4) The department will compare CA samples to QC samples. Obtain CA samples by retaining a QC split portion conforming to the "rule of retained" requirements, as provided in section 5 of the department's QMP guide/procedure manual. Alternatively the contractor may have CA personnel take an additional sample during production. If taking an additional sample, the contractor may, with the engineer's approval, replace one of the required random QC tests for that day with the CA sample.

460.2.8.2.2.5 Documentation

- (1) Report CA test results to the engineer and the contractor's field staff within 2 business days after receiving the samples.

460.2.8.2.2.6 Allowable Differences

- (1) Differences between the QC and CA split sample test results are acceptable in limiting liability, as provided in section 5 of the department's QMP guide/procedure manual, if within the following limits:

ITEM	ALLOWABLE DIFFERENCES
Percent passing 12.5 mm sieve	6.0
Percent passing 9.5 mm sieve	6.0
Percent passing 4.75 mm sieve	5.0
Percent passing 2.36 mm sieve	4.0
Percent passing 600 µm sieve	3.5
Percent passing 75 µm sieve	2.0
Marshall bulk specific gravity	0.030
Maximum specific gravity	0.020

460.2.8.3 Department Testing

460.2.8.3.1 Quality Verification Program

460.2.8.3.1.1 General

- (1) The engineer will conduct QV tests to determine the quality of the final product and measure characteristics that predict relative performance.

460.2.8.3.1.2 Personnel Requirements

- (1) The department will provide at least one HMA technician, certified under HTCP at level I or higher, to observe QV sampling of project mixtures. An HMA technician certified at level I or higher, or an HMA ACT under the direct supervision of an HMA technician certified at level I or higher, will split, test, analyze data, and post data. The department will make an organizational chart available at the testing laboratory and to the contractor before mixture production begins. The department's chart will include names, telephone numbers, and current certifications of all QV testing personnel. The department will update the chart with appropriate changes, as they become effective.

460.2.8.3.1.3 Laboratory Requirements

- (1) The department will furnish and maintain a facility for QV testing conforming to the department's laboratory qualification program requirements and fully equipped to perform QV testing. In all cases, the department will conduct testing in a separate laboratory from the contractor's laboratory.

460.2.8.3.1.4 Department Verification Testing Requirements

- (1) HTCP certified department personnel will obtain random samples by directly supervising HTCP certified contractor personnel sampling from trucks at the plant. The department will sample according to section 5 of the department's QMP guide/procedure manual. Sample size must be adequate to run the appropriate required tests in addition to one set of duplicate tests that may be required for dispute resolution. The engineer will split the sample for testing and retain the remaining portion for additional testing if needed.
- (2) The department will verify product quality using the test methods enumerated here in 460.2.8.3.1.4(2), other engineer-approved methods, or other methods the industry and department HMA technical team recognizes. The department will identify test methods before construction starts and use only those methods during production of that material unless the engineer and contractor mutually agree otherwise.
- (3) The department will perform all testing conforming to the following standards:
- Bulk specific gravity (Gmb) of the compacted mixture according to AASHTO T 166.
 - Maximum specific gravity (Gmm) according to AASHTO T 209.
 - Air voids (Va) by calculation according to AASHTO T 269.
 - VMA by calculation according to AASHTO PP 28.
- (4) The department will test each design mixture at the following minimum frequency:

FOR TONNAGES TOTALING:

Less than 501 tons (455 Mg) no tests required
From 501 (455 Mg) to 30,000 tons(27 215 Mg) one test
More than 30,000 tons (27 215 Mg).....add one test for each additional 30,000-ton (27 215 Mg) increment

460.2.8.3.1.5 Documentation

- (1) The engineer will document all observations during QV sampling, and review QC mixture adjustments and QC/CA test results daily. The engineer will note results of observations and inspection records in a permanent field record as they occur.

460.2.8.3.1.6 Acceptable Verification Parameters

- (1) The engineer will provide test results to the contractor within 2 mixture-production days after obtaining the sample. The quality of the product is acceptably verified if it meets the following limits:
 - Va is within a range of 2.7 to 5.3 percent.
 - VMA is within minus 1.5 of the minimum requirement for the mix design nominal maximum aggregate size.
 - Average differences in running averages, when applying the QV test results as an additional QC data point, are within 0.5 of the previous running average point for both Va and VMA.
- (2) If QV test results are outside the specified limits, the engineer will investigate immediately through dispute resolution procedures. The engineer may stop production while the investigation is in progress if the potential for a pavement failure is present.
- (3) If production continues, the engineer will provide additional CA testing at the frequency provided for in section 5 of the department's QMP guide/procedure manual. This supplemental testing will continue until the material meets the acceptable limits or as the engineer and contractor mutually agree.

460.2.8.3.1.7 Dispute Resolution

- (1) When QV test results do not meet the specified limits, the bureau's AASHTO accredited laboratory and certified personnel will referee test the retained portion of the QV sample and the retained portion of the nearest available previous QC sample.
- (2) The department will notify the contractor of the referee test results within 2 business days after receipt of the samples.
- (3) The department will determine mixture conformance and acceptability by analyzing referee test results, reviewing mixture project data, and inspecting the completed pavement all according to section 5 of the department's QMP guide/procedure manual.

460.2.8.3.1.8 Corrective Action

- (1) Remove and replace unacceptable material at no additional expense to the department.
- (2) The department will reduce pay for nonconforming mixtures from the QV test tonnage, backward to the nearest QV or QC/CA point acceptable for limiting liability. If production continued during the investigation, the department will also adjust pay for that mixture forward to the next conforming QV or QC/CA point. The department will pay for the affected mixture at 50 percent of the contract price for nonconforming air void content and 75 percent of the contract price for nonconforming VMA. The department will adjust pay for both the mixture and the asphaltic material.

460.2.8.3.2 Independent Assurance Testing

- (1) The department will evaluate both the contractor and department testing personnel and equipment as specified in [106.3.4.3.6](#).

460.3 Construction

460.3.1 General

- (1) Construct HMA pavement conforming to the general provisions of [450.3](#).

460.3.2 Thickness

- (1) Provide the plan thickness for lower and upper layers limited as follows:

NOMINAL SIZE	MINIMUM LAYER THICKNESS in inches (mm)	MAXIMUM LOWER LAYER THICKNESS in inches (mm)	MAXIMUM UPPER LAYER THICKNESS in inches (mm)
37.5 mm	3.5 (89)	5 (127)	4.5 (114)
25.0 mm	3.25 (83)	5 (127)	4 (102)
19.0 mm	2.25 (57)	4 (102)	3 (76)
12.5 mm ^[1]	1.75 (44)	3 (76) ^[2]	2.5 (64)
9.5 mm ^[1]	1.5 (38)	3 (76) ^[2]	2 (51)

^[1] SMA mixtures use nominal size 12.5 mm or 9.5 mm.

^[2] SMA mixtures with nominal sizes of 12.5 mm and 9.5 mm have no maximum lower layer thickness specified.

460.3.3 HMA Pavement Density Maximum Density Method

460.3.3.1 Minimum Required Density

- (1) Compact all layers of HMA mixture to the density table 460-3 shows for the applicable mixture, location, and layer.

TABLE 460-3 MINIMUM REQUIRED DENSITY^[1]

LOCATION	LAYER	PERCENT OF TARGET MAXIMUM DENSITY		
		MIXTURE TYPE		
		E-0.3, E-1, and E-3	E-10, E-30, and E-30x	SMA
TRAFFIC LANES ^[2]	LOWER	91.5 ^[3]	92.0 ^[3]	94.0
	UPPER	91.5	92.0	94.0
SHOULDERS AND APPURTENANCES	LOWER	89.5	89.5	91.0
	UPPER	90.5	90.5	91.0

^[1] The table values are for average lot density. If any individual density test result falls below 87% of the target maximum density, the engineer may investigate the acceptability of that material.

^[2] Includes parking lanes as determined by the engineer.

^[3] Minimum reduced by 2 percent for < 3 million ESALs and one percent for > 3 million ESALs, for that lower layer constructed directly on crushed aggregate or recycled base courses.

460.3.3.2 Pavement Density Determination

- (1) The engineer will determine the target maximum density using department procedures. The engineer will measure pavement density for either nuclear density or the density of sawed or cored samples. The engineer and contractor will decide which method to use before paving. A change to the method requires agreement between the engineer, contractor, and the department's quality management section. The engineer will determine density as soon as it is practical after compaction and before placement of subsequent layers. Cut pavement samples as the engineer directs and restore the surface with new, well compacted mixture.
- (2) Do not re-roll compacted mixtures with deficient density test results. Do not operate continuously below the specified minimum density. Stop production, identify the source of the problem, and make corrections to produce work meeting the specification requirements.
- (3) A lot represents 750 tons (680 Mg) of a mixture placed within a single layer for each location and target maximum density category indicated in table 460-3.
- (4) For nuclear density, the department will test 5 random samples on each lot. A nuclear density technician certified at level I will perform the testing. For the density of sawed or cored samples, the department will test 3 random samples, each at least 28 square inches (18 000 mm²) in area, from each lot. The lot density is the average of all samples taken for that lot. The department will provide density results to the contractor weekly.

460.3.3.3 Waiving Density Testing

- (1) The engineer may waive density testing for one or more of the following reasons:
1. It is not practical to determine density by the lot system.
 2. The contract contains less than 750 tons (680 Mg) of a given mixture type placed within the same layer and target maximum density category.
- (2) If the department waives density testing, the department will accept the mixture by the ordinary compaction procedure as specified in [450.3.2.6.2](#).

460.4 Measurement

- (1) The department will measure the HMA Pavement bid items acceptably completed by the ton as specified in [450.4](#).
- (2) The department will not measure QMP HMA Mixture for material if the engineer waives the QMP testing requirements.

460.5 Payment

460.5.1 General

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
460.1100	HMA Pavement Type E-0.3	TON
460.1101	HMA Pavement Type E-1	TON
460.1103	HMA Pavement Type E-3	TON
460.1110	HMA Pavement Type E-10	TON
460.1130	HMA Pavement Type E-30	TON
460.1132	HMA Pavement Type E-30X	TON
460.1700	HMA Pavement Type SMA	TON
460.2000	Incentive Density HMA Pavement	DOL
460.3000	QMP HMA Mixture	TON

460.5.2 HMA Pavement

460.5.2.1 General

- (1) The department will pay for the HMA Pavement bid items at the contract unit price subject to one or more of the following adjustments:
1. Disincentive for density of HMA pavement as specified in 460.5.2.2.
 2. Incentive for density of HMA pavement as specified in or [460.5.2.3](#).
 3. Reduced payment for nonconforming smoothness as specified in [450.3.2.9](#).
 4. Reduced payment for nonconforming QMP HMA mixtures as specified in [460.2.8.2.1.7](#).
- (2) Payment for HMA Pavement Type E-0.3, E-1, E-3, E-10, E-30, and E-30x is full compensation for providing HMA mixture designs; for preparing foundation; and for furnishing, preparing, hauling, mixing, placing, and compacting mixture; for all materials except asphaltic materials.
- (3) Payment for HMA Pavement Type SMA, is full compensation for providing HMA mixture designs; for preparing foundation; and for furnishing, preparing, hauling, mixing, placing, and compacting the mixture; for all materials including asphaltic materials; for stabilizer, hydrated lime, and liquid antistripping agent if required.
- (4) If provided for in the plan quantities, the department will pay for a leveling layer, placed to correct irregularities in an existing paved surface before overlaying, under the pertinent paving bid item. Absent a plan quantity, the department will pay for a leveling layer as extra work.
- (5) Except for SMA mixes, the department will pay for asphaltic materials separately under the Asphaltic Materials bid items as specified in [455.5](#). Except for SMA mixes, hydrated lime or liquid antistripping agent, when required, is included in the contract price for the asphaltic material.
- (6) If the department waives density testing under [460.3.3.3](#), the department will not adjust pay under either 460.5.2.2 or [460.5.2.3](#).
- (7) Restore the surface after cutting density samples as specified in [460.3.3.2\(1\)](#) at no additional cost to the department.

460.5.2.2 Disincentive for HMA Pavement Density

- (1) The department will administer density disincentives under the Disincentive Density HMA Pavement and the Disincentive Density Asphaltic Material administrative items. If the lot density is less than the specified minimum in table 460-3, the department will reduce pay based on the contract unit price for both the HMA Pavement and Asphaltic Material bid items for that lot as follows:

DISINCENTIVE PAY REDUCTION FOR HMA PAVEMENT DENSITY

PERCENT LOT DENSITY BELOW SPECIFIED MINIMUM	PAYMENT FACTOR (percent of contract price)
From 0.5 to 1.0 inclusive	98
From 1.1 to 1.5 inclusive	95
From 1.6 to 2.0 inclusive	91
From 2.1 to 2.5 inclusive	85
From 2.6 to 3.0 inclusive	70
More than 3.0 ^[1]	—

^[1] Remove and replace the lot with a mixture at the specified density. When acceptably replaced, the department will pay for the replaced work at the contract unit price. Alternatively the engineer may allow the nonconforming material to remain in place with a 50 percent payment factor.

- (2) If the engineer directs placing HMA mixtures between October 15 and May 1 for department convenience as specified in [450.3.2.2\(5\)](#), the department will not assess a density disincentive on pavement the department orders the contractor to place when the temperature, as defined in [450.3.2.1\(2\)](#), is less than 36 F (2 C).

460.5.2.3 Incentive for HMA Pavement Density

- (1) If the lot density is greater than the minimum specified in table 460-3 and all individual air voids test results for that mixture placed during the same day are within +1.0 percent or - 0.5 percent of the design target in table 460-2, the department will adjust pay for that lot as follows:

INCENTIVE PAY ADJUSTMENT FOR HMA PAVEMENT DENSITY

PERCENT LOT DENSITY ABOVE SPECIFIED MINIMUM	PAY ADJUSTMENT PER LOT ^[1]
From -0.4 to 1.0 inclusive	\$0
From 1.1 to 1.8 inclusive	\$300
More than 1.8	\$600

^[1] The department will prorate the pay adjustment for a partial lot.

- (2) The department will adjust pay under the Incentive Density HMA Pavement bid item. Adjustment under this item is not limited, either up or down, to the bid amount shown on the schedule of items.
- (3) The department will restrict incentive payment as follows:
1. For shoulders paved integrally with the traffic lane, if the traffic lane does not meet incentive requirements, the department will not pay incentive on the integrally paved shoulder.
 2. If part of a lot is started or finished on a day when an individual air void test does not meet the air void criteria of 460.5.2.3(1), the entire lot is not eligible for incentive.

460.5.3 QMP HMA Mixture

- (1) Payment for QMP HMA Mixture is full compensation for sampling, testing, and documenting all contractor activities required under the department's QMP. The department will not pay for QMP HMA Mixture for material if the engineer waives the QMP testing requirements.

SECTION 465 ASPHALTIC SURFACE

465.1 Description

- (1) This section describes constructing asphaltic surface for new construction including pavement, safety islands, curb, rumble strip, and flumes. This section also describes using asphaltic surface for patching, detours, and temporary construction. The department will designate work under the bid items in this section only if the QMP provisions specified for HMA pavements under section 460 are not required.

465.2 Materials

- (1) Under the Asphaltic Surface, Asphaltic Surface Detours, and Asphaltic Surface Patching bid items; submit a mix design. Furnish asphaltic mixture meeting the requirements specified for either type E-0.3, E-1, or E-3 under [460.2](#); except the engineer will not require the contractor to conform to the quality management program specified under [460.2.8](#).
- (2) Under the other section 465 bid items, the contractor need not submit a mix design. Furnish aggregates mixed with a type AC asphaltic material, except under the Asphaltic Curb bid item, furnish PG64-22 asphaltic material. Use coarse and fine mineral aggregates uniformly coated and mixed with the asphaltic material in an engineer-approved mixing plant. The contractor may include reclaimed asphaltic pavement materials in the mixture.

465.3 Construction

465.3.1 General

- (1) Prepare the foundation as specified for asphaltic surfacing in [section 211](#).
- (2) Place using engineer-approved machine methods wherever it is practical. Except for the surfacing bid items, the contractor may place material by engineer-approved hand methods. Regardless of the placement technique, spread and shape the material to the required contour without segregation.
- (3) Immediately after placement, compact the mixture to produce a dense smooth surface using ordinary compaction procedures as specified in [450.3.2.6](#) except as follows:
 - Compact safety islands as the engineer directs.
 - Compact flumes using compactors, tampers, or rollers.
 - Compact curb as specified in 465.3.2.
- (4) Ensure that the finished surface is smooth and contoured as the plans show or engineer directs.
- (5) Under the Asphaltic Surface, Asphaltic Surface Detours, and Asphaltic Surface Temporary bid items; straightedge the surface. Provide a finished surface with no variation greater than 1/4 inch (6 mm) in 10 feet (3 m). Remove and replace out-of-tolerance material or correct the surface using engineer-approved methods.

465.3.2 Asphaltic Curb

- (1) Construct asphaltic curb in one course on a prepared asphaltic pavement or base foundation. Clean the pavement surface area the curb will occupy to ensure a good bond. Apply a tack coat to the area as the engineer directs.
- (2) The contractor may place the curb by one of the following methods:
 - With an engineer-approved curb laying machine that places and compacts the mixture and finishes the curb to the required shape, grade and dimensions.
 - In forms fabricated to the curb shape. Place and thoroughly compact the mixture with vibratory compactors or mechanical tampers and screed to a smooth finish.
 - For small quantities, by hand placing and shaping. Form the back of the curb. Place, tamp, and shape with hand tools. Provide a smooth-finished surface on the curb face and top.

465.3.3 Rumble Strips

- (1) Construct asphaltic rumble strips by milling the asphaltic shoulder surface. Use a rotary head milling machine with a cutting tip pattern that will produce a relatively smooth cut of the size, shape, spacing, and smoothness the plans show. Cutting heads shall be on a suspension independent from the power unit to allow the heads to self-align with slopes and irregularities. The machine shall have a guidance system that consistently provides the plan alignment of the rumble strips.
- (2) Before beginning the work, demonstrate to the engineer that the operation achieves the desired surface inside each depression without tearing or snagging the asphaltic pavement or surfacing. Place rumble

strips in the pattern and shape the plans show. For shoulders carrying temporary traffic during construction, do not install rumble strips until after routing traffic back to the mainline.

- (3) At the end of each work day, move equipment and material out of the clear zone and sweep or vacuum the traveled way pavement and shoulder areas. Sweep away or vacuum up milling debris before opening adjacent lanes to traffic. Dispose of waste material as specified in [203.3.4](#).

465.3.4 Maintenance

- (1) Maintain work done under the Asphaltic Surface Temporary bid item for the time the contract specifies.

465.4 Measurement

- (1) The department will measure the Asphaltic Surface bid items by the ton acceptably completed using the methods specified in [450.4](#). The department will not measure asphaltic materials separately.
- (2) The department will measure Asphaltic Curb by the linear foot acceptably completed, measured along the base of the curb face.
- (3) The department will measure Asphaltic Flumes and Asphaltic Intersection Rumble Strip by the square yard acceptably completed.
- (4) The department will measure Asphaltic Shoulder Rumble Strip by the linear foot acceptably completed, measured as the length along each side of the traveled way, from the center of the first groove in a segment to the center of the last groove in that segment.

465.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
465.0105	Asphaltic Surface	TON
465.0110	Asphaltic Surface Patching	TON
465.0115	Asphaltic Surface Detours	TON
465.0120	Asphaltic Surface Driveways and Field Entrances	TON
465.0125	Asphaltic Surface Temporary	TON
465.0305	Asphaltic Surface Safety Islands	TON
465.0310	Asphaltic Curb	LF
465.0315	Asphaltic Flumes	SY
465.0400	Asphaltic Shoulder Rumble Strip	LF
465.0450	Asphaltic Intersection Rumble Strip	SY

- (2) Payment for the Asphaltic Surface bid items is full compensation for submitting an asphaltic mixture design, if required; for preparing the foundation; for providing the asphaltic mixture, including asphaltic material and reclaimed asphaltic pavement materials; and for compacting the mixture.
- (3) Payment for Asphaltic Surface Temporary is also full compensation for maintenance during the time the contract specifies.
- (4) Payment for Asphaltic Curb is full compensation for providing the asphaltic mixture, including asphaltic material and reclaimed asphaltic pavement materials; for compacting the mixture; and for forming the curb.
- (5) Payment for Asphaltic Flumes is full compensation for preparing the foundation; for providing the asphaltic mixture, including asphaltic material and reclaimed asphaltic pavement materials; and for compacting the mixture.
- (6) Payment for Asphaltic Shoulder Rumble Strip and Asphaltic Intersection Rumble Strip is full compensation for milling; for sweeping or vacuuming; and for disposing of all waste materials.

SECTION 475 SEAL COAT

475.1 Description

- (1) This section describes applying asphaltic material and an aggregate cover on a previously completed surface.

475.2 Materials

- (1) Furnish asphaltic materials for seal coat conforming to [section 455](#).
- (2) Furnish aggregates conforming to [section 460](#) except as follows:
 1. Aggregate retained on the No. 4 (4.75 mm) sieve shall have 10 percent, by weight, or less thin or elongated pieces based on a 5:1 ratio.
 2. The percent wear, measured according to AASHTO T 96, shall not exceed 40 after 500 revolutions.
 3. At least 60 percent, by count, of the aggregate retained on the No. 4 (4.75 mm) sieve shall have one or more fractured face.
 4. Conform to the following gradation requirements:

SIEVE SIZE	PERCENT PASSING BY WEIGHT
1/2 inch (12.5 mm)	100
No. 4 (4.75 mm)	0-60
No. 16 (1.18 mm)	0-5

475.3 Construction

475.3.1 General

- (1) Construct seal coat to the full width of the existing surface unless the contract or engineer specify otherwise. Use asphaltic material of the type and grade the special provisions designate. Apply at the plan rate.
- (2) Apply asphaltic material only if the air temperature is 60 F (16 C) or more, and the surface is clean and dry. Do not apply before impending rains if rain might damage the material before placing and rolling the cover aggregates. Limit the surface area treated with asphaltic material in a single day to the amount that can be covered with aggregate and rolled during daylight hours.

475.3.2 Equipment

- (1) Provide equipment to heat and distribute asphaltic material as specified for applying tack coat in [455.3.2.2](#).
- (2) Provide additional equipment as follows:
 - Power broom.
 - Mechanical spreader capable of applying aggregate uniformly at the plan rate.
 - Self-propelled steel-wheel roller weighing between 6 and 9 tons (5 and 8 Mg).
 - Self-propelled, pneumatic-tire roller.
- (3) Use pneumatic-tire rollers with tires on one axle arranged to cover the spaces between tires on the other axle. Ensure that all tires are the same size and uniformly inflated. During roller operation, ensure that the wheel load and tire contact pressure is 30 pounds per square inch (207 kPa) or greater, unless the contract specifies otherwise. If the engineer requests, furnish manufacturer documentation showing the contact areas and contact pressures for various wheel loadings and tire inflation pressures.
- (4) Ensure all rollers are in good mechanical condition, capable of operating both forwards and backwards, and the operating mechanism allows for starting, stopping, or reversing direction in a smooth manner, without loosening or distorting the surface being rolled.
- (5) Equip all rollers with a drum or tire lubricator. Do not lubricate with petroleum or tar products.

475.3.3 Preparing the Surface

- (1) Immediately before applying the asphaltic material, clean the existing surface with a power broom or other suitable equipment to remove dirt, clay, or other objectionable matter.

475.3.4 Heating and Applying Asphaltic Material

- (1) Heat and distribute asphaltic material as specified for applying tack coat in [455.3.2](#). Cover previously applied material as required to create transverse joints without overlapping. Close treated areas to traffic until after applying the cover aggregate.

475.3.5 Applying and Rolling Aggregate

- (1) After the asphaltic material develops sufficient tackiness, spread aggregate uniformly over the treated surface. Dry or moisten the aggregate to ensure that it is damp to surface dry. If the engineer directs, moisten the aggregate to control dust. The engineer will determine the appropriate application rate to completely cover the treated surface but limit the application to the amount easily embedded in and bonded by the asphaltic material.
- (2) Roll the surface immediately after spreading the aggregate with a steel-wheel roller. Begin at the edges and continue to the center, lapping 1/2 the roller width on each successive pass. After this initial rolling, perform subsequent rolling using both steel-wheel rollers and pneumatic-tire rollers until thoroughly embedding the aggregate and the surface is smooth and uniform in texture. Regulate the speed and take care when reversing roller direction to avoid displacing or loosening the cover aggregate, or damaging the asphaltic material.
- (3) If the engineer directs, lightly broom the surface to remove excess loose material.

475.3.6 Maintenance

- (1) Maintain the work until acceptance. Repair damage and correct areas with excess or deficient asphaltic material or aggregate cover during this maintenance period.

475.4 Measurement

- (1) The department will measure Seal Coat by the cubic yard or by the ton acceptably completed, measured as the quantity of seal coat aggregate. The department will measure volume or weight in the vehicle and deduct for material wasted or not actually incorporated in the work.

475.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
475.0100	Seal Coat	CY
475.0105	Seal Coat	TON

- (2) Payment for Seal Coat is full compensation for preparing the surface; for heating and applying asphaltic material; for drying or moistening, applying, and rolling the cover aggregate; and for brooming, finishing, and maintaining the surface.
- (3) The department will pay for asphaltic materials separately under the Asphaltic Material Seal Coat bid item as specified in [455.5](#).

SECTION 490 SALVAGED ASPHALTIC PAVEMENT

490.1 Description

- (1) This section describes recovering existing asphaltic pavement or surfacing, from locations the contract or the engineer specifies, and hauling and stockpiling that salvaged material.

490.2 (Vacant)

490.3 Construction

490.3.1 General

- (1) Haul the salvaged material from the grade to the stockpile location.
- (2) Stockpile the salvaged material at a location the contract specifies or where it will minimize the hauling required to place the material under the Salvaged Asphaltic Pavement Base bid item. Prepare the stockpile foundation to minimize contamination of the salvaged material. Ensure that the stockpile foundation is free of clods, lumps, or stones larger than 2-inch (50 mm) in any dimension.
- (3) Unless the contract specifies otherwise, material in excess of that subsequently incorporated in the work under the Salvaged Asphaltic Pavement Base bid item becomes the contractor's property.

490.3.1 Full-Depth Salvaging

- (1) Under the Salvaged Asphaltic Pavement bid item, remove the existing asphaltic pavement or surfacing full-depth without incorporating or damaging the underlying materials. The engineer may suspend the work if excessive amounts of underlying or shoulder materials are included in the removal.

490.3.2 Partial-Depth Salvaging

- (1) Under the Salvaged Asphaltic Pavement Milling bid item, remove the existing asphaltic pavement or surfacing partial-depth. Provide a uniform milled surface that is reasonably plane, free of excessively large scarification marks, and has the grade and transverse slope the plans show or the engineer directs. Do not damage the remaining pavement.
- (2) Use a self-propelled milling machine with depth, grade, and slope controls. Shroud the drum to prevent discharging loosened material into adjacent work areas or live traffic lanes. Provide an engineer-approved dust control system.
- (3) Maintain one lane of the roadway for traffic at all times during working hours. Unless using a continuous removal and pick-up operation, do not windrow or store material on the roadway. Clear the roadway of all materials and equipment during non-working hours. Grade shoulders adjacent to milled areas by the end of each work day to provide positive drainage of the pavement. Do not allow abrupt longitudinal differences of 2 inches (50 mm) or more between lanes during non-working hours. The engineer may waive one or more of these requirements if the highway is closed to traffic or if a particular operation does not endanger traffic.

490.4 Measurement

- (1) The department will measure Salvaged Asphaltic Pavement and Salvaged Asphaltic Pavement Milling either by the ton or square yard acceptably completed.
- (2) For measurement by the ton, the department will determine the weight based on contractor-provided tickets. Give the engineer a ticket, for each load showing the net weight of the load, the type of material, the date, and project number. For small quantities, the engineer may measure the volume in the truck and convert to a weight as allowed under [109.1.4](#).
- (3) The department will make no deductions from the volume measured under the Excavation bid items for pavement removed full-depth under the Salvaged Asphaltic Pavement bid item.

490.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
490.0100	Salvaged Asphaltic Pavement	SY
490.0105	Salvaged Asphaltic Pavement	TON
490.0200	Salvaged Asphaltic Pavement Milling	SY
490.0205	Salvaged Asphaltic Pavement Milling	TON

- (2) Payment for Salvaged Asphaltic Pavement is full compensation for full-depth salvaging; and for hauling and stockpiling the salvaged material.
- (3) Payment for Salvaged Asphaltic Pavement Milling is full compensation for partial-depth salvaging; and for hauling and stockpiling the salvaged material.

PART 5 STRUCTURES

SECTION 501 CONCRETE

501.1 Description

- (1) This section describes proportioning, mixing, placing, and protecting concrete mixtures.

501.2 Materials

501.2.1 Portland Cement

- (1) Use cement conforming to ASTM specifications as follows:
 - Type I portland cement; ASTM C 150.
 - Type II portland cement; ASTM C 150.
 - Type III portland cement; ASTM C 150, for high early strength.
 - Type IP portland-pozzolan cement, ASTM C 595, except maximum loss on ignition is 2.0 percent.
 - Type IS portland blast-furnace slag cement, ASTM C 595.
 - Type I(SM) slag-modified cement, ASTM C 595.
- (2) Store cement of different types, brands, and sources separately. Keep batches of concrete made from different types, brands, and sources from becoming intermixed in the work, unless the engineer approves otherwise.
- (3) The engineer will reject cement that is partially set or that contains lumps.
- (4) The engineer may reject cement if, the temperature at the time of delivery to the mixer exceeds 165 F (74 C). To avoid this, store it until it cools to at least 165 F (74 C) before incorporating into the batch.

501.2.1.1 Testing

- (1) Test according to AASHTO standard methods.
- (2) Determine fineness by the air permeability test method performed according to AASHTO T 153.
- (3) If testing for setting time, base results on the Gillmore test method according to AASHTO T 154.

501.2.1.2 Certification

- (1) Contractors using portland cement concrete shall obtain it from manufacturers whose products comply with the department's certification method of acceptance for portland cement, unless the engineer agrees to accept the cement according to the alternate procedures in the department's certification method referenced above.

501.2.2 Air Entraining Admixtures

- (1) If using an air entraining admixture, the contractor must submit evidence based on tests made in a recognized laboratory to show that the material conforms to AASHTO M 154 for 7- and 28-day compressive and flexural strengths and resistance to freezing and thawing, except as specified in 501.2.2(2). The engineer will not require tests for bleeding and setting time. Within section 501, a recognized laboratory is any state department of transportation, FHWA, or any cement and concrete laboratory regularly inspected by the Cement and Concrete Reference Laboratory. The department may test samples taken from a quantity that the contractor submits for use on the project, or it may test samples the manufacturer submits and certifies as representative of the admixture it is supplying.
- (2) Admixtures manufactured by neutralizing vinsol resin with caustic soda (sodium hydroxide) are an exception to the requirements in the above paragraph. If the contractor plans to use this admixture, then it must submit a certification of the admixture in the following form:

"This is to certify that the product (trade name) as manufactured and sold by the (company) is an aqueous solution of vinsol resin that has been neutralized with sodium hydroxide. The ratio of sodium hydroxide to vinsol resin is one part of sodium hydroxide to (number) parts of vinsol resin. The percentage of solids based on the residue dried at 221 F (105 C) is (number). No other additive or chemical agent is present in this solution."
- (3) If the contractor offers to use an admixture that is essentially the same (with only minor differences in concentration) as another previously department-approved material, the department will require a certification stating it is essentially the same as the department-approved admixture, and that it contains no other admixture or chemical agent.

- (4) The department will not require a certification for admixtures on the department's list of approved materials.
- (5) Either before, or at any time during construction the engineer may require further testing on the admixture the contractor selects to determine its effect on the strength of the concrete. If tested, the 7-day compressive strength of the concrete sample made with enough of the admixture to produce the specified percent, +/- the specified tolerance percent, of entrained air in the plastic concrete shall not be less than 88 percent of the concrete strength made with the same materials, cement content, and consistency but without the admixture.
- (6) Calculate the percentage reduction in strength from the average strength of at least five standard 6 inch (150 mm) by 12-inch (300 mm) cylinders of each type of concrete. Make and cure these specimens in the laboratory according to AASHTO T 126 and test according to AASHTO T 22. Determine the percentage of entrained air according to AASHTO T 152.
- (7) The department will reject admixtures failing to conform to the above requirements.

501.2.3 Retarding, Water Reducing, and Non-Chloride Accelerating Admixtures

501.2.3.1 General

- (1) The engineer must approve all retarding and water reducing admixtures not on the department's approved list of materials before using them.
- (2) The engineer will base approval of retarding and water reducing admixtures on tests made in the department's laboratory, or evaluation of results of tests made in a recognized laboratory as defined in [501.2.2\(1\)](#). The manufacturer shall furnish test result data. Provide to the engineer a manufacturer's certification that the materials it is furnishing are essentially identical to those used in the performance testing.
- (3) The department will maintain an approved listing of admixtures. The contractor may use admixtures included in the current approved list, provided they produce the required properties in the concrete.
- (4) Based on manufacturer furnished data, the indicated relationships between temperature of mix, quantity of admixture, and time of initial set must satisfy the engineer.
- (5) The contractor shall provide the laboratory and the engineer with manufacturer's data required for evaluations indicated above and for determining quantities of admixture for job conditions.
- (6) Retarding and water reducing admixtures, as specified in this section, may or may not increase the amount of air entrained in the mix. If using admixtures in air-entrained concrete, ensure the concrete mix air content is within the range specified for air-entrained concrete under [501.3.2.4](#).

501.2.3.2 Retarding Admixtures

- (1) All admixtures used to retard concrete setting as specified for set retarder under [501.3.2.4.3](#) shall conform to AASHTO M 194, type D.

501.2.3.3 Water Reducing Admixtures

- (1) If using water-reducing admixtures in concrete, conform to AASHTO M 194, type A or type D, except that if adding a retarding admixture as specified for set retarder under [501.3.2.4.3](#), do not use type A.

501.2.3.4 Non-Chloride Accelerating Admixtures

- (1) Conform to AASHTO M 194, type C or type E.

501.2.4 Water

501.2.4.1 General

- (1) Use water with cement in concrete, mortar, neat cement paste, or wash, and in other cement mixing operations conforming to the following:

501.2.4.2 Requirements

- (1) The contractor may use drinking water from municipal water supplies for cement, except the engineer may test this water for compliance with the requirements specified below.

- (2) Water from other sources shall comply with the following:

Acidity, maximum amount of 0.1N NaOH to neutralize 200 mL of water	2 mL
Alkalinity, maximum amount of 0.1N HCL to neutralize 200 mL of water	15 mL
Maximum sulphate (SO ₄)	0.05 percent
Maximum chloride.....	0.10 percent
Maximum total solids:	
Organic	0.04 percent
Inorganic	0.15 percent

- (3) Use water that is not brackish and is clean and free of injurious amounts of sugar, oil, or other deleterious substances.
- (4) Use water that causes no indication of unsoundness, no significant change in the time of setting, and varies no more than 10 percent in the strength of standard 1:3 mortar briquettes from strengths obtained with mixtures containing distilled water and the same cement and sand.

501.2.4.3 Sampling and Testing

- (1) Submit samples that each consist of at least 2 quarts (2 L) of water, obtained and shipped in clean plastic or glass containers, carefully packed and labeled. The engineer will supervise sampling. Test according to AASHTO T 26.

501.2.4.4 Source

- (1) Do not use water from shallow, muddy, or marshy sources. The contractor shall not use water from suspected sources until the engineer tests and approves it. If supply sources are relatively shallow, enclose the suction pipe intake to keep out silt, mud, grass, and other foreign materials. Position the suction pipe to provide at least 2 feet (600 mm) of water beneath the pipe intake.

501.2.5 Aggregates

501.2.5.1 General

- (1) Furnish and use coarse and fine aggregates conforming to the requirements below.
- (2) The engineer may prohibit using aggregates from any source, plant, pit, quarry, or deposit if the character of the material or method of operation makes it unlikely to furnish aggregates conforming to specified requirements; or from deposits or formations known to produce unsound materials.
- (3) Before use, furnish samples of materials from previously untested sources and from previously tested sources if the engineer requires.
- (4) If procuring aggregates from pits or quarries, conform to [104.9](#) for final cleanup.

501.2.5.2 Definitions

- (1) Use the definitions in [301.2.1](#), [450.2.1](#), and the following:

Fine aggregates Those aggregates that entirely pass the 3/8-inch (9.5 mm) sieve, almost entirely pass the No. 4 (4.75 mm) sieve and are predominantly retained on the No. 200 (75 µm) sieve.

Coarse aggregates Those aggregates predominantly retained on the No. 4 (4.75 mm) sieve.

501.2.5.3 Fine Aggregates

- (1) Fine aggregate consists of a combination of sand with fine gravel, crushed gravel, or crushed stone consisting of hard, strong, durable particles.

501.2.5.3.1 Deleterious Substances

- (1) Do not exceed the following percentages:

SUBSTANCE	PERCENT BY WEIGHT
Material passing the No. 200 (75 µm) sieve	3.5 ^[1]
Coal	1.0
Clay lumps.....	1.0
Shale	1.0
Other local deleterious substances like alkali, mica, coated grains, soft and flaky particles	1.0

^[1] Reduce to 2.3 percent if used in grade E concrete.

- (2) The total percentage of coal, clay lumps, shale, and other deleterious substances shall not exceed 3.0 percent by weight. There is no requirement to wash fine aggregate for portland cement concrete if produced otherwise to conform to all specified requirements. When used, the fine aggregate shall not contain any of the following: frozen material, and foreign material like wood, hay, burlap, paper, or dirt.

501.2.5.3.2 Organic Impurities

- (1) Fine aggregate shall not contain harmful amounts of organic impurities. The engineer will reject aggregates, subjected to the colorimetric test for organic impurities, producing a darker than standard color, unless they pass the mortar strength test.

501.2.5.3.3 Mortar Strength

- (1) Fine aggregates, if tested for the effects of organic impurities on strength of mortar, using type I cement, must produce a relative strength at 7 days, calculated according to section 8 of AASHTO T 71, of not less than 95 percent.

501.2.5.3.4 Size Requirements

- (1) Use well-graded fine aggregate conforming to the following gradation requirements:

SIEVE SIZE	PERCENT PASSING BY WEIGHT
3/8 in. (9.5 mm).....	100
No. 4 (4.75 mm).....	90 - 100
No. 16 (1.18 mm).....	45 - 85
No. 50 (300 µm).....	5 - 30
No. 100 (150 µm).....	0 - 10

501.2.5.4 Coarse Aggregates

501.2.5.4.1 General

- (1) Use clean, hard, durable gravel, crushed gravel, crushed stone or crushed concrete free of an excess of thin or elongated pieces, frozen lumps, vegetation, deleterious substances or adherent coatings considered injurious. Do not use coarse aggregates obtained from crushing concrete in concrete for bridges, culverts, or retaining walls.

501.2.5.4.2 Deleterious Substances

- (1) The amount of deleterious substances shall not exceed the following percentages:

DELETERIOUS SUBSTANCE	PERCENT BY WEIGHT
Shale	1.0
Coal	1.0
Clay lumps	0.3
Soft fragments	5.0
Any combination of above	5.0
Thin or elongated pieces based on a 3:1 ratio	15.0
Materials passing the No. 200 (75 µm) sieve.....	1.5
Chert ^[1] for all grades of concrete other than concrete for prestressed concrete members	5.0 ^[2]
Chert ^[1] for concrete for prestressed concrete members.....	2.0

^[1] Material classified lithologically as chert and having a bulk specific gravity (saturated surface-dry basis) of less than 2.45. Determine the percentage of chert by dividing the weight of chert in the sample retained on a 3/8-inch (9.5 mm) sieve by the weight of the total sample.

^[2] The engineer may accept aggregates exceeding this value if aggregates from the same deposit or from one of similar geological origin demonstrated a satisfactory service record, or tests the engineer select indicate no inferior behavior.

- (2) If using 2 sizes of coarse aggregates, the engineer will determine the percentages of harmful substances based on one of the following: a sample consisting of 50 percent of size No. 1, and 50 percent of size No. 2; or a sample consisting of the actual percent of size No. 1 and No. 2 used in the work.
- (3) The engineer will not require the contractor to wash coarse aggregate produced within specified gradations, free of coatings considered injurious, and conforming to the above limits for harmful substances.

501.2.5.4.3 Physical Properties

- (1) The department will conduct the wear test according to AASHTO T 96. The percent wear shall not exceed 50.
- (2) The department will conduct 5 cycles of the sodium sulfate soundness test, according to AASHTO T 104, on aggregate retained on the No. 4 (4.75 mm) sieve. The weighted loss shall not exceed 12 percent.
- (3) The department will conduct freeze-thaw soundness tests, according to AASHTO T 103, on crushed stone aggregates produced from sources in limestone/dolomite formations in specified counties if using those aggregates in concrete pavements or bridge decks. The department will test aggregate retained on the No. 4 (4.75 mm) sieve using one of the following: method A with 50 cycles, method B with 16 cycles, or method C with 25 cycles. The weighted average loss shall not exceed 18 percent.
- (4) The department will conduct freeze/thaw soundness tests, on the fraction retained on the No. 4 (4.75 mm) sieve, for virgin crushed stone aggregates produced from limestone/dolomite sources in one or more of the following counties or from out of state:

Brown	Columbia	Crawford	Dane	Dodge
Fond du Lac	Grant	Green	Green Lake	Iowa
Jefferson	Lafayette	Marinette	Oconto	Outagamie
Rock	Shawano	Walworth	Winnebago	

- (5) The department may waive freeze/thaw testing for existing quarries determined to be in either the Silurian system or the Prairie du Chien group of the Ordovician system of rocks.
- (6) The department may prohibit using crushed stone from limestone/dolomite deposits having thinly bedded strata, or strata of a shale nature; it may also prohibit using aggregates from deposits or formations known to produce unsound material.
- (7) If all coarse aggregates used are produced from the same deposit or source, the department will perform tests for wear, sodium sulfate soundness, and soundness by freezing and thawing on a composite sample. This sample will contain equal percentages of each component coarse aggregate used. If the component coarse aggregates are produced from more than one deposit or source, the department will perform tests for wear, sodium sulfate soundness, and soundness by freezing and thawing on one sample from each deposit or source.

501.2.5.4.4 Size Requirements

- (1) Use well graded course aggregate conforming to the following gradation requirements:

SIEVE SIZE	PERCENT PASSING BY WEIGHT	
	SIZE NO. 1 AASHTO No. 67 ^[1]	SIZE NO. 2 AASHTO No. 4 ^[1]
2 inch (50 mm)	-	100
1 1/2 inch (37.5 mm)	-	90-100
1 inch (25.0 mm)	100	20-55
3/4 inch (19.0 mm)	90-100	0-15
3/8 inch (9.5 mm)	20-55	0-5
No. 4 (4.75 mm)	0-10	-
No. 8 (2.36 mm)	0-5	-

^[1] Size No. according to AASHTO M 43.

- (2) Furnish coarse aggregates in the separate sizes indicated, and store each size separately to prevent mixture until proportioned into each batch. The engineer will allow the contractor to combine 2 aggregate fractions to produce a gradation within the limits specified for size No. 1 or size No. 2, provided they are proportioned separately by weight into the batch in proportions the engineer approves.
- (3) Except as provided below, furnish coarse aggregate conforming to size No. 1 and size No. 2, combined in the proportions specified for the pertinent grade and class of concrete under [501.3.2.2](#).
- (4) Provide coarse aggregate consisting entirely of size No. 1 as follows:
 1. If the engineer approves, for grade A, A2, A3, A-FA, A-S, A-S2, A-T, A-IS, or A-IP concrete.

2. Except for concrete pavement repair and if substituting grade C, C-FA, C-S, C-IS, or C-IP for grade A air entrained high early strength concrete as specified in [501.3.1.1](#), for grade C, C-FA, C-S, C-IS, or C-IP concrete.
3. If the engineer approves, for grade D concrete.
4. Except for concrete pavement repair, for grade E concrete.
5. For concrete in prestressed concrete members.

501.2.5.5 Sampling and Testing

- (1) Sample and test according to the following AASHTO or ASTM methods, except as revised with the engineer's approval:

Sampling aggregates	AASHTO T 2
Lightweight pieces in aggregate	AASHTO T 113
Material finer than No. 200 (75 µm) sieve	AASHTO T 11
Unit weight of aggregate	AASHTO T 19
Organic impurities in sands	AASHTO T 21
Sieve analysis of aggregates	AASHTO T 27
Effect of organic impurities in fine aggregate	AASHTO T 71
Los Angeles abrasion of coarse aggregate	AASHTO T 96
Freeze-thaw soundness of coarse aggregate	AASHTO T 103
Sodium sulfate soundness of aggregates	AASHTO T 104
Specific gravity and absorption of fine aggregate	AASHTO T 84
Specific gravity and absorption of coarse aggregate	AASHTO T 85
Thin or elongated pieces based on a 3:1 ratio	ASTM D 4791
Sampling fresh concrete	AASHTO T 141
Making and curing concrete compressive strength test specimens	AASHTO T 23
Compressive strength of molded concrete cylinders	AASHTO T 22

- (2) The department will determine the quantities of chert, soft or non-durable particles, and thin or elongated pieces, according department laboratory methods.
- (3) The engineer will field evaluate or laboratory test to determine aggregate acceptability relative to excessive clay lump quantities.

501.2.6 Fly Ash

- (1) Fly ash is defined as a finely divided residue resulting from the combustion of coal in a base loaded electric generating plant, transported from the boiler by flue gases, and later collected, generally by precipitators. Use fly ash in portland cement concrete manufactured by facilities and processes known to provide satisfactory material.
- (2) Conform to ASTM C 618 Class C, including the supplemental optional requirements provided, except limit the loss on ignition to a maximum of 2 percent.
- (3) Test fly ash by using a recognized laboratory, as defined in [501.2.2\(1\)](#), 30 days before its proposed use, and every 30 days during the work progress. The manufacturer shall conduct daily uniformity tests on the fly ash. These daily uniformity tests consist of determining the: specific gravity, percent retained on the No. 325 (45 µm) sieve, loss on ignition, moisture content, sulfur trioxide content, and air content of the mortar. The department may reduce the required frequency of the uniformity testing for specific tests on specific fly ash sources if statistical analysis of current data shows no significant probability of exceeding uniformity or specification limits.
- (4) Use only one source of fly ash for a bid item of work under the contract, unless the engineer directs otherwise in writing.
- (5) Prequalify any proposed fly ash source as follows: The contractor shall obtain a copy of the certified report of tests or analysis made by a qualified independent laboratory, recognized by the department under [501.2.2](#), showing full and complete compliance with the above specification from the fly ash manufacturer and furnish it to the project engineer. Provide this report to the engineer at least 14 days before using the fly ash.

- (6) The manufacturer shall retain all test records for at least 5 years after completing the work, and provide these records upon request.

501.2.7 Slag

- (1) For grade A-S, A-T, A-S2, B-S, and C-S concrete, provide ground granulated blast furnace slag conforming to ASTM C 989, grade 100 or 120.

501.2.8 Pozzolans

- (1) The contractor may use pozzolans as a direct replacement for fly ash in concrete mixes. Conform to the replacement limits specified under [501.3.2.2](#) for fly ash. Use only as a complete replacement for fly ash. Do not combine pozzolans or use pozzolans with fly ash in the same mix.
- (2) Furnish pozzolans conforming to the physical, chemical, and performance requirements specified for Class C fly ash in ASTM C618, except the definition of origin of the material does not apply. Obtain material from a manufacturer on the department's approved product list with an in-place quality management program that includes the following daily uniformity tests:
- Specific gravity.
 - Percent retained on the No. 325 (45µm) sieve.
 - Loss on ignition.
 - Moisture content.
 - Activity index with portland cement.

501.3 Construction

501.3.1 Concrete Classes and Grades

501.3.1.1 Concrete Classes

- (1) Use the following concrete classes, prepared with portland cement, conforming to ASTM specifications for the types of cement specified for the designated class, except as specified for prestressed girders in [503.2.2](#) and for special high early strength concrete pavement repair in [416.2.5](#).
- (2) Use these 2 classes of concrete in the work: air entrained concrete and air entrained high early strength concrete.

501.3.1.1.1 Air Entrained Concrete

- (1) Prepare air entrained concrete with type I, II, IS, I(SM) or IP cement and sufficient air entraining admixture to produce concrete with the air content specified in [501.3.2.4](#).

501.3.1.1.2 Air Entrained HES Concrete

- (1) If required or the engineer allows, prepare air entrained high early strength concrete with type III cement. Instead of this preparation, the contractor may substitute another grade and class of concrete as follows: for grade A or A2 air entrained high early strength concrete use grade C air entrained concrete, and for grade B air entrained high strength concrete use grade A air entrained concrete.

501.3.1.2 Use of Concrete Classes

- (1) Unless the contract specifies otherwise, and except as allowed for prestressed girders in [503.2.2](#), use air entrained concrete for all concrete in the work.
- (2) The contractor may use high early strength concrete for bridge substructures and in other structures if the contract requires, or at the contractor's option, if the engineer approves, but the contractor shall not use it for bridge superstructures.

501.3.1.3 Concrete Grades

501.3.1.3.1 General

- (1) Unless the contract specifies otherwise, and except as specified for pre-stressed concrete members in [section 503](#) and for special high early strength concrete pavement repair in [416.2.5](#), provide the grade of concrete specified below in [501.3.1.3.2](#) or [501.3.1.3.3](#). If the contractor selects and uses a specific grade of concrete for an item of work, then use that grade throughout the entire construction of the item, except as specified in [501.3.1.3.3](#), or as the engineer approves.

501.3.1.3.2 Special Restrictions

- (1) If using coarse aggregate composed primarily of igneous or metamorphic materials, provide concrete for concrete pavement, approach slabs, barrier, surface drains, driveways, alleys, sidewalks, curb, gutter, and curb & gutter as follows:

Grade A, A-FA, A-S, and A-T : If using type II portland cement.

Grade A-S2 : If placing by a slip-formed process and using type II portland cement.

Grade C, C-FA, C-S, C-IS, and C-IP : If using types I or III portland cement.

501.3.1.3.3 General Use

- (1) If using concrete not covered in 501.3.1.3.2, use the grade of concrete as follows:

Grade A, A-FA, A-S, A-T, A-IS, and A-IP : Except as specified for other grades; for concrete pavement, concrete in structures, and incidental construction.

Grade A-FA, A-S, A-T, A-IS, A-IP and D : For concrete for structures if used in decks, curbs, railings, parapets, medians and sidewalks.

Grade A2 and A-S2 : For concrete pavement, curb, gutter, curb & gutter, barrier , or sidewalk if placing by a slip-formed process.

Grade A3 : For concrete pavement and incidental construction on low volume State Trunk Highways and other roads under municipal or local jurisdiction in areas that a proven performance record exists for similar mixes. Use only in locations and applications specifically delineated in the contract.

Grade B, B-FA, B-S, B-IS, and B-IP : For concrete base.

Grade C, C-FA, C-S, C-IS, and C-IP : For concrete pavement repair and other uses if required in the contract.

Grade D : For concrete seals as modified in [502.3.5.3](#).

Grade E : For overlays and repairs on decks of structures and approaches.

501.3.2 Concrete Composition

501.3.2.1 General

- (1) Except as required for prestressed concrete members and for special high early strength concrete pavement repair, or unless the contract specifies otherwise, use the values tabulated for the grades of concrete in 501.3.2.2 as the master limits of the job mix governing material proportions incorporated in the batch. The engineer will designate, within these limits, the exact proportional weights of fine and coarse aggregates, the maximum quantity of water to use, and the batch weights of the remaining mix ingredients.
- (2) Incorporate into each batch the quantity of cement; admixture; slag, or fly ash if necessary; water; and fine and coarse aggregates the engineer designates for the concrete grade produced.

501.3.2.2 Concrete Proportions

- (1) The following table specifies the master limits of the job mix for the several grades of concrete, and designates the quantities of materials and relative proportions for each grade of concrete. Use the proportions given in the table for high early strength concrete, as required or allowed if using high early strength cement.
- (2) The quantities of aggregates specified in the tabulations are for oven-dry materials with a bulk specific gravity of 2.65. For aggregates with a different specific gravity, adjust the weights in the ratio so that the specific gravity of the material used relates to 2.65. The tabulated design water and maximum water amounts are for total free water in the mix and do not include the water absorbed in the aggregate.

QUANTITIES FOR A NOMINAL CUBIC YARD ^[1]							
CONCRETE GRADE ^{[2][3][6]}	CEMENT ^{[4][5]} (lb)	CLASS C FLY ASH (lb)	SLAG ^[7] (lb)	WEIGHT TOTAL AGG (lb)	PERCENT FINE AGG ^[8] (% total agg)	DESIGN WATER (gals)	MAXIMUM WATER (gals)
A	565	-	-	3120	30-40	27	32
A2	530	-	-	3190	"	25	30
A3	517	-	-	3210	"	25	30
A-FA ^{[9][10]}	395	170	-	3080	"	27	32
A-S ^{[9][10]}	395	-	170	3100	"	27	32
A-S2 ^[10]	285	-	285	3090	"	27	32
A-T ^{[9][11]}	395	Total fly ash and slag of 170 ^[11]		3090	"	27	32
A-IP ^[9]	565	-	-	3100	"	27	32
A-IS ^[9]	565	-	-	3090	"	27	32
B	400	-	-	3300	"	25	31
B-FA ^[10]	280	120	-	3270	"	25	31
B-S ^[10]	280	-	120	3280	"	25	31
B-IP	400	-	-	3280	"	25	31
B-IS	400	-	-	3280	"	25	31
C	660	-	-	2980	"	30	36
C-FA	560	100	-	2960	"	30	36
C-S	560	-	100	2970	"	30	36
C-IP	660	-	-	2970	"	30	36
C-IS	660	-	-	2950	"	30	36
D	610	-	-	3040	"	29	34
E	823	-	-	2810	50	32	35

QUANTITIES FOR A NOMINAL CUBIC METER ^[1]							
CONCRETE GRADE ^{[2][3][6]}	CEMENT ^{[4][5]} (kg)	CLASS C FLY ASH (kg)	SLAG ^[7] (kg)	WEIGHT TOTAL AGG (kg)	PERCENT FINE AGG ^[8] (% total agg)	DESIGN WATER (liters)	MAXIMUM WATER (liters)
A	335	-	-	1854	30-40	134	157
A2	315	-	-	1892	"	126	148
A3	307	-	-	1907	"	123	147
A-FA ^{[9][10]}	235	100	-	1828	"	134	157
A-S ^{[9][10]}	235	-	100	1843	"	134	157
A-S2 ^[10]	169	-	169	1836	"	134	157
A-T ^{[9][11]}	235	Total fly ash and slag of 100 ^[11]		1835	"	134	157
A-IP ^[9]	335	-	-	1840	"	134	157
A-IS ^[9]	335	-	-	1836	"	134	157
B	237	-	-	1959	"	126	154
B-FA ^[10]	166	71	-	1940	"	126	154
B-S ^[10]	166	-	71	1947	"	126	154
B-IP	237	-	-	1947	"	126	154
B-IS	237	-	-	1948	"	126	154
C	392	-	-	1766	"	149	176
C-FA	332	60	-	1757	"	149	176
C-S	332	-	60	1763	"	149	176
C-IP	392	-	-	1763	"	149	176
C-IS	392	-	-	1752	"	149	176
D	362	-	-	1803	"	145	170
E	488	-	-	1667	50	156	171

- [1] A nominal cubic yard (m³) has the tabulated weights of cement and aggregate, design mix water, and 6.0 % air.
- [2] For all grades, use a water reducing admixture conforming to [501.2.3.3](#) and [501.3.2.4.4](#).
- [3] For all grades, provide air entrainment as specified in [501.3.2.4.2](#).
- [4] For grades A-IP, B-IP, and C-IP, use only type IP cement.
- [5] For grades A-IS, B-IS, and C-IS, use only type IS or I(SM) cement.
- [6] For grade D, use a water reducing admixture conforming to [501.3.2.4.4](#). Do not use type A (M 194) water reducing admixture if using a set retarding admixture as required in [501.3.2.4.3.2](#).
- [7] For grade C-S concrete, use only grade 120 slag.
- [8] If using crushed stone or recycled concrete coarse aggregate, the engineer may allow up to 45% fine aggregate.
- [9] For bridge substructures, the contractor may use a non-chloride accelerating admixture conforming to [501.2.3.4](#).
- [10] If using less than the tabulated maximum quantities of fly ash or slag, calculate the cement content by reducing the base cement content for the grade A or B mix by the weight of fly ash or slag added.
- [11] For ternary mixes containing cement, fly ash, and slag, if using less than the tabulated maximum combined quantity of fly ash and slag, calculate the cement content by reducing the base cement content for the grade A mix by the combined weight of fly ash and slag added.
- (3) The total coarse aggregate quantity equals the difference between the total aggregate and the fine aggregate. Proportion this total quantity between the 2 sizes as necessary to secure suitable workability and ensure that it is within the range of 35-65 percent of size No. 1, with size No. 2 comprising the remainder, except if only one size is required as specified for size requirements in [501.2.5.4.4](#).

501.3.2.3 Job Mix

- (1) From the master limits of the job mix, adjusted as necessary for the specific gravities of the aggregate furnished, the engineer will determine the job mix, using the lowest quantity or percentage of fine aggregate within the range shown that, without exceeding the maximum quantity of water allowed, yields a mix of the necessary workability.
- (2) The difference between the amount of fine aggregate determined above and the total amount of aggregate equals the coarse aggregate proportioned between the 2 sizes within the limits set, except if only one size is required. If the character of the proposed aggregates prohibits producing a workable mix within the maximum fine aggregate and water limits, then reduce the total quantity of aggregates sufficiently and re-proportion the mix to produce a workable mix without exceeding the maximum water allowed. The amount of water allowed includes the free moisture in the aggregates, minus the absorbed moisture determined according to AASHTO T 84 and T 85. Use just the amount of water needed, without exceeding the maximum that in the engineer's judgment produces a mixture of the consistency, plasticity, and workability required for the work. The engineer will designate, as the work progresses, the amount of water to use for each batch and will either make or direct adjustments. The engineer will determine the stockpile moisture of the aggregates, or the absorption of moisture by aggregate during mixing and handling throughout construction as job conditions warrant; and the engineer will make any corrections in aggregate weights for moisture as necessary. Within the designated limits, the contractor may vary relative proportions of fine and coarse aggregate from the initial determination, as the characteristics of the aggregate necessitate, maintaining workability.
- (3) Except as specified above, the contractor shall not make adjustments in the mix or its proportions, or adjust the total quantity of aggregate as necessary for the specific gravities, or exceed the moisture content shown in the tabulation.
- (4) These requirements do not guarantee yield.

501.3.2.4 Concrete Admixtures

501.3.2.4.1 General

- (1) Dispense admixtures in liquid form only. Incorporate non-liquid admixtures in an aqueous solution according to the manufacturer's instructions before dispensing. Maintain admixtures at uniform concentration. The contractor is responsible for the uniform operation of the admixture and for its compatibility with other mix components and any other admixture used.

501.3.2.4.2 Air Entrainment

- (1) Use an admixture with non-entrained portland cement to produce air entrainment under the circumstances specified below.
- (2) If using admixtures for air entrainment, conform to [501.2.2](#).
- (3) Ensure that concrete air content conforms to the following requirements:
 - Grade E concrete shall contain 6.0 percent air, +/- 1.0 percent.
 - Slip formed concrete pavement shall contain 7.0 percent air, +/- 1.5 percent.
 - All other grades of concrete contain 6.0 percent air, +/- 1.5 percent.
- (4) Any miscellaneous concrete cast monolithically with slip formed concrete pavement must conform to the same entrained air requirements as the pavement. Use a quantity of admixture sufficient to provide the proper percentage.
- (5) Perform tests for air entrainment throughout the progress of work with a frequency, and at the intervals, the engineer specifies. Perform air entrainment tests for concrete placed by pumping at the point of discharge from the pump line.
- (6) Perform air entrainment tests on freshly produced concrete.
- (7) During testing, the engineer may employ any accepted procedures that measure the air volume directly. The contractor may request a check test on these tests in the event of dispute or controversy over the procedure the engineer selected. The engineer will perform the check test according to AASHTO T 152.

501.3.2.4.3 Set Retarder

501.3.2.4.3.1 General

- (1) Use admixtures to retard concrete setting conforming to [501.2.3](#).

501.3.2.4.3.2 Bridge Superstructures

- (1) If required, add a retarding admixture conforming to [501.2.3](#) to the concrete mix used for the superstructures of cast in place reinforced concrete slab and deck girder bridges, concrete floor slabs, curbs, sidewalks, railings, and parapets of other types of structures, including the top slab of concrete for box girder bridges according to the following:
- (2) Add the department-approved retarding admixture, to the concrete mix, as the engineer directs, if the air temperature when placing the concrete is 70 F (21 C) or above; or if it is 50 F (10 C) or above and it is expected to take 4 or more hours to place the concrete in any one span or pour. Add the retarding admixture in the proportions the manufacturer recommends for the anticipated temperature.

501.3.2.4.3.3 Extended Delivery Time

- (1) If the contractor elects to use a retarder to extend delivery time for Ready Mixed Concrete, as specified for delivery in [501.3.5.2](#), add it to the concrete mix if the air temperature when placing the concrete is 60 F (16 C) or above.
- (2) Add the retarding admixture according to the manufacturer's instructions to obtain at least a one-hour delay in the initial set, as defined in AASHTO T 197, at the temperature during placement.

501.3.2.4.4 Water Reducer

- (1) Add a water reducing admixture conforming to [501.2.3](#) to all grades of concrete except as prohibited by footnote 6 of the Master Limits of Job Mix table, [501.3.2.2](#). Determine the specific type and rate of use based on the atmospheric conditions, the desired properties of the finished concrete and the manufacturer's recommended rate of use. The actual rate of use shall at least equal the manufacturer's recommended rate, and both the type and rate used require the engineer's approval before use.

501.3.3 Handling Materials

501.3.3.1 Aggregates

- (1) Keep all materials required to manufacture concrete clean and free from contamination. The department will not accept aggregates mixed with foreign matter. Keep the fine aggregate and the coarse aggregates separate until measuring and placing in the batch. If mixing or storing aggregates from different supply sources in the same pile, the engineer will reject the entire pile. The engineer may approve use of aggregates from different sources alternately in the same class of construction or mix; this permission is contingent on amending the job mix and batch weights as necessary to protect the concrete quality produced.

- (2) If using a composite material from 2 or more sources for any aggregate for a job mix, proportion material from the respective sources separately into the batch by weight in the proportions the engineer approves.
- (3) Store aggregates in stockpiles. The aggregates shall not go directly from the washing plant to the proportioning bins. After washing, drain fine aggregate in stockpiles for at least 12 hours before weighing for the batch, unless the engineer reduces this waiting period. After washing and before placing in the proportioning plant, allow coarse aggregates to drain for periods that ensure reasonable uniformity in the moisture content.
- (4) Choose reasonably smooth, firm, and well-drained sites for aggregate stockpiles cleared of vegetable matter and foreign material that might contaminate the aggregates. If necessary, build adequate bulkheads or partitions for keeping the fine and the several sizes of coarse aggregates separated. If the aggregates become intermixed, then do not use them.
- (5) Construct coarse aggregate stockpiles in a manner that minimizes segregation of the coarse and fine fractions.
- (6) Exercise care in removing aggregates near the bottom of stockpiles, to avoid incorporating foreign materials, and use of material removed from near the bottom of drainage stockpiles at production plants and batching plants is prohibited unless tests indicate the material is satisfactory.

501.3.3.2 Cement

- (1) Handle bulk cement in a manner that precludes contamination and avoids loss.
- (2) If using packaged cement, deposit it directly from the containers, as shipped, into the mixer when placing the aggregates into the mixer, or dump it directly on the batch aggregates just before placing the batch aggregates into the mixer, except as required otherwise to conform to [415.3.15](#) and [502.3.9.2](#) for mixing concrete under cold weather conditions. Take care to place the container's full contents into the batch.

501.3.3.3 Fly Ash or Slag

- (1) Use separate facilities equal to those used for portland cement for handling, storing, transporting, and conveying the fly ash or slag.

501.3.4 Proportioning

501.3.4.1 Aggregates

- (1) Measure the specified quantities of each size of fine and coarse aggregates by weight into each batch, except as specified for volumetric plant and mixer in [501.3.6.4](#).

501.3.4.2 Cement

- (1) Measure the specified amount of cement accurately into each batch.
- (2) The contractor may proportion cement in sacks by volume if the operations allow the engineer to accurately determine the amount of cement proportioned into each batch. Do not use batches requiring a fractional part of a sack of cement, unless the contractor elects to weigh the fractional part required for each batch.
- (3) Proportion cement in bulk by weight, except as specified for volumetric plant and mixer in [501.3.6.4](#).

501.3.4.3 Water

- (1) Measure water by volume or by weight. Use water-measuring equipment capable of accurately measuring to within one percent of the quantity required for each batch. Ensure that the measurement accuracy is uniform under all construction conditions and that variations in pressure in the water supply line do not affect it.
- (2) Use water-measuring equipment with preset controls that enable the operator to automatically cut off the flow after discharging the required amount of water. Use equipment that has an accurately calibrated and easily read indicator showing the amount of water used in each batch. Arrange this measuring equipment to facilitate checking the calibration accuracy.

501.3.4.4 Admixtures

501.3.4.4.1 General

- (1) The contractor may proportion admixtures by volume or by weight. Follow an department-approved procedure for adding the specified amount of each admixture. Add admixtures during initial batching of the concrete except as specified in 501.3.4.4.2.
- (2) If using more than one admixture, add each admixture in a manner that prevents intermixing the admixtures before incorporating into the mixture. The contractor may introduce the admixture into the water line, directly into the mixer when adding the water, or uniformly dispense it into the fine aggregate just before incorporating into the mix.

501.3.4.4.2 Adding Air-Entraining Admixtures in the Field

- (1) The department will allow re-tempering with air-entraining admixtures at the work site for concrete delivered in truck mixers.
- (2) If additional air entraining admixture is needed at the work site to raise the air content of the concrete above the lower specification limit, measure it in a calibrated container and then add to the mixer in a dilute solution with water. Mix the concrete at mixing speed for at least 30 revolutions before discharge.

501.3.4.5 Weighing Equipment for Aggregates

501.3.4.5.1 General

- (1) The contractor may use manual, automatic, or semi-automatic batching plants for weighing fine and coarse aggregates.
- (2) Ensure each plant has bins for holding each aggregate weighed, and batchers, and scales for weighing the aggregates, and conforms to the requirements specified below.
- (3) The contractor may use batching plants that are a complete unit with bins, batchers, and scales mounted on a rigid framework for direct discharge of the aggregate from the bin to the batcher; or plants with the bins mounted separately from the batchers and provided with appropriate means for conveying the aggregate from the bin to the batcher. Ensure the framework supporting bins and batchers is rigidly constructed and mounted on firm foundations.
- (4) After erection, test each batching plant before use. Fully load aggregate bins, batchers, and scales with aggregate for not less than 5 hours before testing, in order to allow for settlement and adjustment under working conditions.
- (5) Provide each batching plant with at least 10 standard 50 pound (22.68 kg) weights accurate to within 0.1 percent.
- (6) When the engineer is observing the testing, furnish any accessories and assistance required to test the weighing and metering equipment. If difficulties occur in calibrating and testing the weighing or metering equipment, or if discrepancies occur during use, the engineer may require an authorized testing firm or agency test the scales or meters. If testing weighing equipment, ensure the material bins are fully loaded at the time.
- (7) The contractor may batch aggregates, both fine and coarse, in separate or accumulative weigh batchers.

501.3.4.5.2 Scales

- (1) Use either the beam, digital, or springless dial-type scales suitable for supporting the batcher and of a simple rugged design with a minimum number of adjustments, consistent with the accuracy required. Use scales designed and constructed to prevent displacement of scale parts and that provide a means for readily checking the proper position and alignment of scale levers. Ensure all pivots are constructed of material that satisfactorily resists wear under repeated weighing and are set accurately in substantial mountings to ensure a permanent spacing of the knife edges under all loading and use conditions.
- (2) If provided beam scales, they must have a separate beam, or separate beam and fractional beam for each aggregate weighed. Provide each beam with a sliding poise and locking device to firmly hold it in position. Provide a means to display to the scale operator that the required load weight is approaching, for example, a springless dial indicator or tare beam. If using a graduated dial, provide it with a separate movable pointer or marker for each aggregate weighed. Set these pointers or markers to indicate the load of each aggregate as required. Provide a moisture resistant dial face.
- (3) If using digital scales, conform to NIST handbook 44.

- (4) Design, build, and maintain the scales to an accuracy within 0.4 percent of the net load in the hopper. Arrange the scales or indicating devices so the operator can maintain full view of them.
- (5) Use graduated dials, beams, or other indicators to allow readings or settings made to within 0.1 percent of the capacity of the scale.
- (6) Ensure accessibility to all the scale working parts for inspection and cleaning, and protect all working parts against contamination. Provide full and complete instructions for setting up and adjusting the scale.

501.3.4.5.3 Manually Operated Batching Plants

- (1) Bins shall have: suitable size and shape, no leakage, compartments or separate bins for each size of aggregate, rigid framework that, if mounted on a suitable foundation, holds them in the correct position.
- (2) Multiple compartment bins shall have partitions that extend above the top of the bins to prevent intermixing of the separate sizes of aggregates if heaped above the top of the bins.
- (3) Weigh batchers shall: have suitable size and shape, not leak, rest entirely upon the scales, and hang free. Provide clearance between the batcher top and bin discharge gates, or charging facilities, to house a full batch without hand raking, and sufficient clearance to remove any overload of aggregate. Provide a means to tightly close the batcher discharge gate during the batching interval. Ensure the design, construction, and operation of the batcher and its appurtenances does not retain varying tare materials on any of its parts, and completely and quickly discharges without shaking or jarring the scales.

501.3.4.5.4 Automatic and Semi-Automatic Batching Plants

- (1) Use automatic and semi-automatic plants with bins, batchers, and scales conforming to the requirements specified above for manually operated batchers.
- (2) Provide a means to protect the device for setting the batch weights against tampering by unauthorized personnel.
- (3) Provide an audible signal device activated by the discharge of any batch whose weight is outside the specified tolerance. Ensure a loud enough signal to hear throughout the plant area under normal operating conditions.
- (4) Provide automatic and semi-automatic batching plants with a device to indicate any underweight or overweight material.
- (5) Provide automatic batching equipment with batching devices that if activated by a single starting mechanism, automatically batches or measures any given material, and automatically stops the flow of material after attaining the desired amount, within the allowable tolerance.
- (6) Use an interlocking batcher charging mechanism on automatic plants that guards against opening until the batcher entirely discharges and the scale balances within ± 0.3 percent of the scale capacity, and against opening if the batcher discharge gate is open. Also, it should interlock to ensure against opening if the batcher charging mechanism is open, and against opening if the batch is either over or underweight by more than 1.5 percent of the specified batch weight in individual batchers or 1.5 percent of the specified intermediate and final accumulative batch weight in accumulative batchers.
- (7) Provide semi-automatic batching equipment with suitable batching devices that open or start separately, if actuated by individual starting mechanisms, to allow weighing or measuring the material, and close or stop automatically after attaining the desired amount, within the allowable tolerance.
- (8) Use an interlocking batcher discharge mechanism for semi-automatic plants to ensure against opening if the batch is either over or underweight by more than 1.5 percent of the specified batch weight in individual batchers, or 1.5 percent of the specified intermediate and final accumulative batch weights in accumulative batchers.
- (9) Ensure that the batcher discharge mechanisms of automatic or semi-automatic plants interlock against opening until all aggregate batchers and the cement batcher are charged with the correct weights.
- (10) Equip the batching system with automatic controls to stop the cycle in the underweight check position and the overweight check position for each material to allow tolerance limit checking.
- (11) The contractor may use a batching system consisting of a combination of automatic and semi-automatic batchers provided it furnishes the appropriate controls and interlocks.
- (12) If the control system of automatic or semi-automatic batching plants breaks down, the contractor may manually operate plants for up to 72 hours while making repairs.

501.3.4.6 Weighing Equipment for Cement, Fly Ash and Slag

- (1) The contractor may use manual, automatic, or semi-automatic batchers for batching cement. If using a combination of bin, batcher, and scales to proportion cement in bulk, conform to [501.3.4.5](#) for batching plants, with the following additions and exceptions:
- (2) Use a separate batcher and scales.
- (3) If using a beam scale, provide a tare beam and a weigh beam or beams capable of being lifted out of weighing position to allow checking the batcher's tare weight to determine if it discharges all the cement into the batch, unless there are other positive means to determine if complete discharge took place.
- (4) Mechanically operate the batcher discharge gate in a manner that does not affect the scale balance.
- (5) Ensure that the batcher charging mechanism of automatic batchers interlock against opening until the batcher entirely discharges and the scale balances within ± 0.3 percent of scale capacity, and against opening if the batcher discharge gate is open. Also, it should interlock against opening if the batcher charging mechanism is open; and against opening if the batch is either over or underweight by more than one percent of the specified batch weight.
- (6) If using semi-automatic batchers, ensure the batcher discharge mechanism interlocks against opening if the batch is either over or underweight by more than one percent of the specified batch weight.
- (7) Ensure that the batcher discharge mechanisms of automatic or semi-automatic plants interlock against opening until charging the cement batcher and all aggregate batchers with the correct weight.
- (8) The contractor may weigh and batch fly ash or slag along with the portland cement, but if this occurs, weigh the portland cement into the batcher first, and then add the fly ash or slag to the top of the batch of cement to the appropriate accumulative weight.
- (9) For separate scales, bins, and hoppers used to batch fly ash or slag conform to the requirements specified above for cement-weighing equipment.

501.3.4.7 Dispensing Equipment for Admixtures

- (1) Use accurate, volumetric, mechanical measuring dispensers, capable of presetting to deliver a specified amount of admixture, or engineer-approved scales. Furnish a separate volumetric dispenser or scale for each admixture. Use a dispensing system with a device that either detects and indicates the presence or absence of flow of the admixture, or provides a convenient means of visually observing the admixture during batching or discharging. Ensure that the dispenser piping is free from leaks and properly valved to prevent back flow or siphoning.
- (2) Interlock admixture-dispensing systems used in conjunction with semi-automatic plants, automatic plants or on-site mixers of 21 cubic feet (0.6 m³) or more with the batching operations. Ensure that the system is capable of dispensing the admixture within ± 3.0 percent of the required volume or weight of admixture, or the minimum dosage rate per 100 pounds (45.4 kg) of cement, whichever is greater.

501.3.5 Ready-Mixed Concrete

501.3.5.1 General

- (1) The contractor may use ready-mixed concrete instead of site-mixed concrete, except for grade E concrete. Do not use ready-mixed concrete to produce grade E concrete.
- (2) Interpret ready-mixed concrete to include central-mixed, transit-mixed, and shrink-mixed concrete, defined as follows:

Central-mixed concrete Concrete completely mixed in a stationary mixer and transported to the point of delivery with or without mechanical agitation in the transporting vehicle.

Transit-mixed concrete Concrete completely mixed in a truck mixer.

Shrink-mixed concrete Concrete mixed partially in a stationary mixer with the mixing completed in a truck mixer.

501.3.5.2 Delivery

- (1) Deliver ready-mixed concrete at a rate that ensures reasonably continuous progress in the placing and finishing operations. If the time intervals between successive loads or batches causes a partial drying of previously placed concrete provide additional equipment of the kind necessary to preclude these delays. Failing in this, discontinue use of ready-mixed concrete and use site-mixed concrete.

- (2) Provide sufficient facilities for the production and delivery of ready-mixed concrete for concrete pavement to ensure placement at a uniform rate of not less than 80 cubic yards (60 m³) per hour, unless performing single-lane construction.
- (3) For ready-mixed concrete delivered in agitating vehicles, deliver and completely discharge the concrete within the following limits, beginning when adding water to the cement, or when adding cement to the aggregates.
 - 1. 1 hour if the air temperature is 60 F (16 C) or higher at placement, and the contractor does not use a department-approved retarder.
 - 2. 1.5 hour if the air temperature is less than 60 F (16 C) at placement.
 - 3. 1.5 hour if the air temperature is 60 F (16 C) or higher at placement, and the contractor uses a department-approved retarder.
- (4) The engineer or inspector may reduce these times under conditions contributing to quick stiffening of the mix, or during cold weather when loss of heat occurs to the extent that the concrete temperature is not correct at placement.
- (5) Except during the mixing revolutions, operate the drum or agitator of the vehicle at agitating speed until discharging the mix. Ensure the concrete's uniform composition, required consistency, and required air content at time of delivery.
- (6) The contractor may deliver central-mixed concrete to the work site by equipment with non-agitating body types. These body types are smooth, mortar-tight, metal containers capable of discharging the concrete at a satisfactorily controlled rate. Do not use aluminum bodies. Provide watertight covers for protection against the weather if necessary. Delivery time in non-agitating type bodies ensures complete discharge within 30 minutes after introducing the mixing water to the cement or the cement to the aggregates. The concrete in these vehicles should show no appreciable water gain at the surface. The concrete should freely and readily discharge from the vehicle, be free of excessive segregation of the fine and coarse aggregates, and have an air content within the required range at the point of discharge. Slump tests made during discharge should not differ by more than 2 inches (50 mm). Thoroughly wash the compartments of all vehicles that concrete is transported in before receiving a succeeding batch.

501.3.5.3 Mixers and Mixing

- (1) The contractor may use stationary mixers, or truck mixers of the revolving drum type or, with the engineer's written approval, other types specifically designed for mixing. For agitators, use truck mixers or truck agitators. The manufacturer shall attach in a prominent place, to each stationary mixer, truck mixer, or truck agitator a metal plate plainly marked with the various uses of the equipment, the drum or container capacity in volume of mixed concrete, and the rotation speed of the mixing drum or blades.
- (2) If using a stationary mixer to mix concrete, mix at least one minute, provided that plant operating procedures are reasonably stabilized and controlled, and that it achieves visible blending of materials during charging to the engineer's satisfaction. If this mix time does not achieve proper stabilization, control, and blending, the engineer may increase the mixing time to 75 seconds.
- (3) Exceptions to the minimum mixing time for stationary mixers specified above are contained in an approved list, the department's Bureau of Highway Construction maintains, of reduced minimum mixing times for specific makes and models of stationary mixers. If these department-approved reduced minimum mixing times do not produce satisfactory stabilization, control, and blending the engineer may increase the mixing time as needed.
- (4) Blending implies a uniform volume of flow of all batch ingredients throughout the charging time interval, except for the brief introduction of water and coarse aggregate. Charge the batch into the mixer so that:
 - 1. Some water enters shortly before the solid material, and all water is in the drum by the time mixing begins.
 - 2. Introduce admixtures uniformly throughout the charging time interval.
 - 3. Introduce some coarse aggregate before other solid materials.
 - 4. For the remaining solid material charging time, introduce the large and small sizes of the coarse aggregate, sand, and cement in an acceptably uniform rate of flow, as determined by visual inspection.
 - 5. Start mixing time after all solid materials are in the mixer.
- (5) The maximum mixing time for stationary mixers shall not exceed the minimum specified above, by more than 60 seconds.

- (6) Consider transfer time in multiple drum mixers as part of the mixing time.
- (7) For stationary mixers, compute the total mixed concrete volume based on nominal cubic yard (m^3) of concrete as specified in [501.3.2.2](#) and this volume shall not exceed the manufacturer's rated maximum mixing capacity, for the type and volume of mixer used, in the concrete plant mixer standards of the Concrete Plant Manufacturer's Bureau.
- (8) Equip stationary mixers with a timing device that automatically locks the discharge mechanism during the full mixing time and releases it at the end of the mixing period.
- (9) If mixing concrete in a truck mixer, mix each batch for 70 or more revolutions at the manufacturer designated mixing speed. Do not exceed 300 total revolutions per batch, the sum of the revolutions at mixing and agitating speeds. Begin mixer revolutions only after all materials, including mixing water are in the mixer.
- (10) Add the mixing water at the batching plant, but if obtaining the specified slump requires more water, add it in the field with the engineer's permission. Do not exceed the maximum water specified in [501.3.2.2](#). Calculate the maximum water as the sum of free water added with the aggregates and all added mixing water. If adding more water at the work site, perform an additional 20 revolutions of the truck mixer at mixing speed before discharging any concrete. The process of adding more water and additional mixing must happen within 45 minutes of introducing the mixing water to the cement or the cement to the aggregates. The engineer may extend the time limit for adding water and additional mixing to 75 minutes for those grades of concrete mixed under the conditions described in [501.3.5.2](#) whose delivery time limit is 1-1/2 hours. If additional mixing revolutions are necessary because of added water at the site, the total revolutions at mixing and agitating speeds shall not exceed 300.
- (11) If using a truck mixer or agitator to transport concrete completely mixed in a stationary mixer, rotate the drum or agitator at the agitating speed during transportation and until discharge.
- (12) Equip truck mixers with an engineer-approved revolution counter. Unless equipped to control and count revolutions at mixing speed, perform mixing at the batching plant or job site with the mixer operated at agitating speed while in transit.
- (13) For truck mixers operating from plants erected to supply concrete to highway projects, if the delivery time is short enough that the truck cannot exceed the maximum number of revolutions at mixing speed in transit, then mixer may operate at mixing speed in transit.
- (14) If using a stationary mixer for partial mixing of the concrete, the contractor may reduce the mixing time in the stationary mixer to the minimum required to blend the ingredients, about 30 seconds.
- (15) If using a truck mixer to finish the partial mixing done in a stationary mixer, mix each batch for 50 or more revolutions at the manufacturer recommended speed. No batch shall exceed 300 total revolutions, the total revolutions at mixing and agitating speeds.
- (16) For truck mixers, compute the total concrete volume mixed per batch based on the nominal cubic yard (m^3) of concrete as specified in [501.3.2.2](#) and shall not exceed the manufacturer's rated capacity, or the following percentages of the drum's gross volume:
 - For complete mixing, 63 percent.
 - For partial mixing, initial (shrink) mixing done in stationary mixer, 70 percent.
- (17) The engineer may obtain representative samples from approximately the 1/6 and 5/6 discharge points of the concrete load of any truck mixer or truck agitator. If the slump of the 2 samples differs by more than one inch (25 mm), or the entrained air content in them differs by more than one percent, correct the condition before using the load.
- (18) For central-mixed or shrink-mixed concrete, if using more than one batch to make up a load, properly proportion each batch using all the ingredients, including admixtures, fly ash, or slag.
- (19) The contractor shall not incorporate water used to clean mixing equipment and accessories into the mix.
- (20) Replace the pick-up and throw-over blades of truck mixers or agitators if any part or section is worn one inch (25 mm) or more below the their original height. Provide a copy of the manufacturer's design, showing dimensions and blade arrangement, upon the engineer's request.

501.3.5.4 Inspection

- (1) Notify the engineer at least 24 hours before the contractor requires delivery of ready-mixed concrete, so the engineer can make the necessary arrangements to inspect and calibrate equipment at the plant.

- (2) Each load of ready-mixed concrete shall carry an inspector signed inspection ticket signifying inspection, mixing time in the case of central plant-mixed concrete, or the start of the batch life as specified in paragraph 3 of [501.3.5.2](#), delivery for transit-mixed concrete, and other pertinent data. Give these tickets to the inspector upon arrival at the job site. The department will only accept loads that arrive in satisfactory condition and that carry an inspection ticket.
- (3) The engineer may waive the above inspection ticket requirement for use of ready-mixed concrete in concrete pavement and associated bid items, if the concrete is proportioned in plants erected specifically for this purpose, provided an engineer-approved operational plan is in effect. The engineer may also waive the requirement for minor quantities of ready-mixed concrete if used in miscellaneous bid items.

501.3.6 Site-Mixed Concrete

501.3.6.1 General

- (1) Site-mixed concrete is concrete manufactured in standard batch or volumetric type portable mixers at the work site. Use volumetric mixers only for work that specifically allows volumetric proportioning.

501.3.6.2 Batch Mixer

- (1) Use a powered revolving drum type mixer conforming to the following requirements, unless the engineer allows another type.
- (2) Maintain the mixer in good working order and operate it in a manner that does not combine the mixed batch with the following dry batch, and so that the ingredients of only one batch are intermixed with each charge of the mixer. Keep charging devices, the throat, and drum interior free of accumulated materials. If charged with the batch, revolve the mixer drum at a speed that does not exceed the manufacturer's specified speed for the mixer, provided the drum makes between 14 and 20 revolutions per minute. Replace pick-up and throw-over blades showing a wear in excess of 3/4 inch (19 mm) from their original factory depth. All mixers must have a rated capacity of at least 5 cubic feet (0.15 m³) of mixed concrete per batch.
- (3) Equip all mixers with an engineer-approved automatic timing device, in proper working order, designed and constructed so that it starts when the charging skip is raised and dumped. The timing mechanism shall have a device that transmits an audible or visible signal when mixing is complete.
- (4) Equip mixers, with a rated capacity of 21 cubic feet (0.6 m³) or more of mixed concrete, with an engineer-approved discharge-locking device, in good working order, and automatically controlled by the timing device.
- (5) Keep the box or compartment containing the timing device closed and locked at all times except for adjustment or repairs. Only the contractor or an authorized representative shall make adjustments under the direct supervision of the engineer or inspector.
- (6) Compute the total volume of concrete mixed per batch based on the nominal cubic yard (m³) as specified in [501.3.2.2](#) and shall not exceed the mixer's rated capacity by more than 10 percent as established by the Mixer Manufacturer's Bureau of the Associated General Contractors of America. The capacities above are contingent on the mixer drum retaining the batch without segregating, spilling, or leaking during charging, mixing, and discharging; and upon adequate methods of handling, placing and finishing the resultant concrete.
- (7) Stop using and repair or replace with a satisfactory mixer, any concrete mixer that is not adequate or suitable for the work, has insufficient power, inefficient mixing action, or has auxiliary units that do not function properly.

501.3.6.3 Batch Mixing Time

- (1) Mix each batch for at least 50 seconds but not more than 90 seconds. During this time, the drum revolves at the rate specified above. Start the mixing time after all solid materials are in the drum.
- (2) Introduce the mixing water to the drum ahead of the other materials and continue to discharge for a short time after all solid materials are in the drum.

501.3.6.4 Volumetric Plant and Mixer

- (1) Use a truck-mounted mobile portland cement concrete plant and mixer, designed for automatic volume proportioning of concrete materials, and for mixing concrete for immediate use at the work site, for grade E concrete, and the engineer may allow its use for bid items from other grades. This machine shall produce a thoroughly mixed and uniform concrete.

- (2) Calibrate the plant on a weight-volume relationship according to the manufacturer's recommended procedures. Recalibrate the plant if changing aggregates and, as the engineer deems necessary.
- (3) Volumetric proportioning equipment and procedures are subject to the engineer's approval. Equip the plant with either a water flowmeter or a recording water meter.

501.3.7 Concrete Consistency

- (1) Concrete shall have a uniform consistency, with all ingredients uniformly distributed throughout the weight, and so that the mortar clings to the coarse aggregate. Concrete shall not have a consistency sufficiently wet so it flows and segregates, or a mealy, dry consistency.
- (2) Use the minimum amount of water that achieves the desired workability, as the engineer determines. Obtain the engineer's approval of any changes in this quantity.

501.3.7.1 Slump

- (1) For concrete for structures or placed in forms, except for grade E and as specified in [502.3.5.3](#) for underwater placement, use a 2 inch (50 mm) to 4 inch (100 mm) slump if hand-consolidated, and 1-inch (25 mm) to 4 inch (100 mm) slump if vibrated. The engineer may increase the slump up to 5 inches (125 mm) for difficult, hand-consolidated placements.
- (2) Grade E concrete shall have a slump of 1/2 inch (13 mm) to one (25 mm) inch.
- (3) For concrete pavements, use the applicable slump specified in [415.3.6](#).
- (4) Perform the slump tests for concrete according to AASHTO T 119.

501.3.8 Placing

501.3.8.1 General

- (1) Except as specified in [501.3.5.2](#) for ready-mixed concrete, place the concrete within 30 minutes of first adding water to the batch. Use placement techniques that minimize segregation. Batch, mix, place, and finish concrete within a monolithic unit as continuously as it is practical.

501.3.8.2 Hot Weather Concreting

501.3.8.2.1 General

- (1) The contractor is responsible for the quality of the concrete placed in hot weather. For concrete placed under the bid items enumerated in 501.3.8.2.1(2), submit a written temperature control plan at or before the pre-pour meeting. In that plan, outline the actions the contractor will take to control concrete temperature if the concrete temperature at the point of placement exceeds 80 F (27 C). Do not place concrete under these bid items without the engineer's written acceptance of that temperature control plan. Perform the work as outlined in the temperature control plan.
- (2) If the concrete temperature at the point of placement exceeds 90 F (32 C), do not place concrete under the following bid items:

Concrete Masonry Bridges	Concrete Masonry Retaining Walls
Concrete Masonry Bridges HES	Concrete Masonry Retaining Walls HES
Concrete Masonry Culverts	Concrete Masonry Endwalls
Concrete Masonry Culverts HES	Concrete Masonry Overlay Decks
- (3) The department will pay \$0.75 per pound for the quantity of ice required to reach a target concrete temperature of 80 F (27 C) if the following conditions are met:
 - 1. The un-iced concrete temperature exceeds 85 F (29 C).
 - 2. The contractor has performed the actions outlined in the contractor's accepted temperature control plan.
 - 3. The contractor elects to use ice.
- (4) If the engineer directs the contractor to use ice when the un-iced concrete temperature is 85 F (29 C) or less, the department will pay \$0.75 per pound for that ice.
- (5) Notify the engineer whenever conditions exist that might cause the temperature at the point of placement to exceed 80 F (27 C). If project information is not available, the contractor should obtain information from similar mixes placed for other nearby work.

501.3.8.2.2 Bridge Decks

- (1) For concrete placed in bridge decks under the bid items enumerated in 501.3.8.2.2(2), submit a written evaporation control plan at or before the pre-pour meeting. In that plan, outline the actions the contractor will take to maintain concrete surface evaporation at or 0.2 pounds per square foot per hour (1kg/m²/hr). Do not place concrete under these bid items without the engineer's written acceptance of that evaporation control plan. If the engineer accepts an evaporation control plan calling for ice, the department will pay \$0.75 per pound (\$1.65/kg) for that ice. Perform the work as outlined in the evaporation control plan.
- (2) If predicting a concrete surface moisture evaporation rate exceeding 0.2 pounds per square foot per hour (1kg/m²/hr), do not place bridge deck concrete under the following bid items:
Concrete Masonry Bridges
Concrete Masonry Bridges HES
Concrete Masonry Overlay Decks
- (3) Provide evaporation rate predictions to the engineer under one or more of the following conditions:
 1. Conditions exist that might cause concrete surface evaporation to exceed 0.2 pounds per square foot per hour (1kg/m²/hr).
 2. The concrete temperature at the point of placement exceeds 80 F (27 C).
 3. The engineer requests that information.
- (4) Compute the evaporation rate from the predicted ambient conditions at the time and place of the pour using the nomograph, or computerized equivalent, specified in CMM figure 9.2-3. Use weather information from the nearest national weather service station. The engineer will use this information to determine if the pour will proceed as scheduled.
- (5) On the day before the pour, the engineer will inform the contractor in writing whether or not to proceed with the pour as scheduled. If the actual computed evaporation rate during the pour exceeds 0.2 pounds per square foot per hour (1kg/m²/hr), the engineer may allow the contractor to complete the pour. If the engineer allows placement to continue, the department will pay \$0.75 per pound (\$1.65/kg) for the quantity of ice required to maintain concrete surface evaporation at or below 0.2 pounds per square foot per hour (1kg/m²/hr). If ice is not available the department will pay for any actions, beyond those described in the contractor's evaporation plan, required to complete the pour as the engineer directs.

501.3.9 Mixing and Protecting During Cold Weather

- (1) Mix, place, and protect all concrete according to the method specified below, applicable to its use.
- (2) Mix, place, and protect all concrete for pavement, pavement repair, pavement widening, pavement gaps, driveways, alleys, headers, surface drains, pavement approach slabs, base, base widening or patching, curb, gutter, curb & gutter, ditch checks, sidewalks, steps that are not a part of a structure, loading zones, safety islands and other concrete of a similar nature as specified in [415.3.15](#).
- (3) Mix, place, and protect all concrete for bridges, culverts, retaining walls, end walls, or any other structure consisting, wholly or in part, of concrete, if placed during cold weather, as specified in [502.3.9](#).

501.3.10 Test Specimens

- (1) The engineer may cast the number of cylinders required to make tests for determining the compressive strength of the concrete. Make test cylinders 6 inches (150 mm) in diameter and 12 inches (300 mm) in height, unless the engineer directs otherwise.
- (2) The engineer will either perform or supervise the sampling, making, curing, and testing of concrete cylinders.
- (3) Make the test specimens from concrete actually used. If the engineer directs, the contractor shall transport the specimens from the work site to the field laboratory or other location the engineer designates. During transportation, embed the specimens in straw, burlap, or other acceptable material to protect them, in a manner the engineer approves. Take care to avoid sudden impacts during hauling and handling that might cause fractures.
- (4) The contractor shall furnish the concrete for test specimens including all materials, except molds; a suitable vehicle the engineer approves, for transporting specimens, if required; materials necessary to properly transport and cure; and labor incidental to preparing, transporting, storing, and curing.

501.4 (Vacant)

501.5 Payment

- (1) The department will not pay directly for the concrete specified under this section. Concrete is incidental to the various bid items using it. Payment under those bid items includes providing all materials, including cement, fly ash, slag, and admixtures; for preparing, transporting, storing, protecting and curing concrete; and for contractor requirements related to testing specified in [501.3.10](#).
- (2) If required to remove and replace any concrete damaged by lack of proper protection. Perform this work at no expense to the department.
- (3) The department will pay for ice used to cool concrete in hot weather as specified in [501.3.8.2](#) under the Ice Hot Weather Concreting administrative item.

SECTION 502 CONCRETE BRIDGES

502.1 Description

- (1) This section describes constructing concrete bridges and concrete parts of other bridges.

502.2 Materials

502.2.1 General

- (1) Furnish and use materials conforming to the requirements specified for the several parts of the completed structure.
- (2) Refer to the following:
 - Concrete [section 501](#)
 - Steel reinforcement..... [section 505](#)
 - Structural steel and miscellaneous metals..... [section 506](#)
 - Waterproofing [section 516](#)

502.2.2 Concrete Composition

- (1) Furnish concrete for bridges conforming to [section 501](#). If the contract specifies, or the engineer allows, use high early strength concrete.
- (2) Do not use high early strength concrete in cast in place bridge superstructures.
- (3) Do not use high early strength concrete in bridge substructures or in other structures unless the contract requires it, or if the engineer allows the contractor, in writing, to use high early strength concrete to expedite the work.
- (4) Provide the concrete grade specified in [501.3.1.3.3](#).
- (5) Use the coarse aggregate sizes specified in [501.2.5.4.4](#) and [501.3.2.2](#).

502.2.3 Falsework

- (1) The engineer will not require the contractor to use new or unused materials in falsework.
- (2) Use timber and piling in falsework of adequate strength and shape, suitable for the purpose intended. Use material that is in good condition, sound, and free from defects that might impair its strength. Use reasonably straight piling capable of withstanding pile driving.
- (3) Use straight steel members, of adequate strength and shape suitable for the purpose intended.

502.2.4 Forms

- (1) The contractor may use wood or metal, or, with the engineer's approval, composite construction. The engineer will not require the use of new, unused material. Use material in good condition, of adequate strength, and of a shape suitable for the purpose intended.

502.2.5 Waterstops

- (1) If not specified in the contract, the contractor may furnish and use either polyvinyl chloride (PVC) or rubberized membrane waterstops. Use polyvinyl chloride waterstops that are a dense, homogeneous material, free from holes and other imperfections, extruded from an elastomeric plastic compound. If using PVC waterstops, conform to the Corps of Engineers' Specification CRD-C 572.
- (2) Select the rubberized membrane, primer, and mastic from a list the department developed and maintains of engineer-approved waterstop products. Use membrane with a minimum thickness of 60 mils (1.5 mm).

502.2.6 Concrete Curing Materials

502.2.6.1 Liquid Membrane-Forming Compounds

- (1) Use liquid curing compounds conforming to AASHTO M 148, type 1-D, clear or translucent with fugitive dye, except as modified for testing in [415.2.4](#).

502.2.6.2 Burlap

- (1) Provide burlap conforming to AASHTO M 182, class 3 or 4. The contractor may use 2 layers of class I or class 2 instead of one layer of class 3 or class 4.

502.2.6.3 Polyethylene Sheeting

- (1) Provide sheeting conforming to AASHTO M 171 for white opaque polyethylene film, except that the contractor may use clear or black polyethylene for cold weather protection.

502.2.6.4 Polyethylene-Coated Burlap

- (1) Provide burlap conforming to AASHTO M 171 for white burlap-polyethylene sheet.

502.2.7 Preformed Joint Filler

- (1) Use preformed joint filler conforming to AASHTO M 153, types I, II or III, or AASHTO M 213.

502.2.8 Preformed Elastomeric Compression Joint Sealer

- (1) Use preformed elastomeric compression joint sealer conforming to AASHTO M 297.
- (2) If installing the preformed joint sealer, use a lubricant-adhesive that is a one-part moisture curing polyurethane and hydrocarbon solvent mixture with the following physical properties:

Average weight per gallon (L)	7.2 to 8.8 pounds (0.9 to 1.1 kg)
Solids content percent	72 to 74 % by weight
Adhesive to remain fluid from	5 F to 120 F (-15 C to 49 C)
Film strength (ASTM D 412)	1200 psi (8.3 MPa)
Elongation	350 %
- (3) Ensure the viscosity of the lubricant-adhesive performs suitably with the application equipment. The engineer will reject any lubricant-adhesive not used within 9 months of manufacture.
- (4) Ensure the lubricant-adhesive consistency works well at the temperatures the seals are installed, is compatible with the seals and the concrete, and is relatively unaffected by the normal moisture in the concrete.
- (5) Deliver the lubricant-adhesive in containers plainly marked with the manufacturer's name or trademark, lot number, and manufacture date.
- (6) Use a joint sealer compatible with concrete, or steel and resistant to abrasion, oxidation, oils, gasoline, salt, and other materials spilled on or applied to the surface.
- (7) Shape the sealer so that in its compressed condition the top center of the exposed surface is depressed below the edges of the installed sealer. At the joints maximum opening, the minimum unit pressure on the sides of the joint sealer shall be 3 pounds per square inch (20.7 kPa).
- (8) Mark the top surface of the seal at one-foot (300 mm) intervals clearly, in a manner durable enough to make length determinations of the seal after installing in the pavement joints.
- (9) Mark shipping containers for seals clearly, with the manufacturer's name, the size of the seal, the lot number, and the manufacture date.

502.2.9 Non-Bituminous Joint Sealer

- (1) Furnish gray sealant complying with ASTM C920 for non-sagging grade NS, class 25, traffic area use T, and either single-component type S, or multi-component type M.

502.2.10 Hot-Poured Elastic Joint Sealer

- (1) Use material conforming to ASTM D3405.

502.2.11 Protective Surface Treatment

- (1) Use a commercial product selected from the department's approved list.
- (2) Use a gray-pigmented product to coat the inside faces of the parapets.

502.2.12 Masonry Anchors

502.2.12.1 Type L Anchors

- (1) Furnish epoxy resin cartridges from a department-approved manufacturer. Use reinforcing bars conforming to [505.2.3](#).
- (2) Anchors shall develop the ultimate strength of the bar.

502.2.12.2 Type S Anchors

- (1) Provide anchors that develop the pullout strength the plans show. If the plans show using reinforcing bars in type S anchors, conform to [505.2.3](#) and anchor with epoxy.
- (2) As the plans show, provide anchors, bolts, studs, nuts, and washers, either hot dipped, or mechanically zinc coated according to AASHTO M 232 or AASHTO M 298, respectively, or made of stainless steel.
- (3) For epoxied anchors, provide a 2-part epoxy resin mixed according to the manufacturer's recommendations.

502.2.13 Clear Protective Coating

- (1) Use clear protective coating composed of the following:

MATERIAL	MINIMUM PERCENT BY WEIGHT
Vinyl resin ^[1]	25.0
Methyl ethyl ketone solvent	37.0
Toluene solvent	37.0

^[1] Use resin of an engineer-approved vinyl chloride-acetate copolymer containing 86 percent vinyl chloride and 14 percent vinyl acetate. Ensure a viscosity of 250-500 centipoises for a 22 percent by weight solution or resin in a solvent, consisting of equal parts of methyl iso-butyl ketone and toluene at 77 F (25 C).

COATING PROPERTY

Weight per gallon (L) at 77 F (25 C)	7.6 pounds (0.9 kg) minimum
Viscosity at 77 F (25 C)	60-70 Krebs units
Color	Clear and colorless
Drying time	1/2 hour maximum

502.3 Construction

502.3.1 General

- (1) Use construction methods conforming to the specifications for the several parts of the completed structure. Understand that the proposed work includes everything reasonably considered necessary for a complete and acceptable job conforming to the plans and contract.

502.3.2 Falsework

502.3.2.1 Detailed Plans

- (1) At the engineer's request, the contractor shall submit one copy of signed and sealed detailed plans and computations for falsework, as specified in [105.2](#), and place on file. If the engineer requests, submit 2 additional copies of plans for review. If the engineer finds the plans and computations submitted unsatisfactory, the contractor shall make the required changes to them. Understand that whether or not the engineer requests submission of these plans or concurs in the use of the submitted or corrected plans, the contractor shall remain responsible for obtaining satisfactory results.

502.3.2.2 Design

- (1) Design falsework to support a weight of 160 pounds per cubic foot (2570 kg/m³) for concrete plus a live load allowance of not less than 10 pounds per square foot (480 Pa) of horizontal projection of forms; and must also provide the necessary rigidity and support for the loads without appreciable settlement or deformation. Consider the potential effects of high wind and high water in the design.

502.3.2.3 Erection

- (1) Build falsework on foundations that are adequate to support the load without appreciable settlement. Drive an ample amount of falsework piling to support the falsework unless there is firm foundation material for the support of mud sills that is not subject to undermining or softening. Construct mud sills of a size and thickness to support the load at the soil's safe bearing value. Generally, found mud sills only on rock, firm sand, gravel, or very firm, silty, sands or clays in their natural beds. Place mud sills founded on well-compacted slopes of berm fills or natural slopes on benches, with the edge of the sill not closer than one foot (300 mm) from the intersection of the bench and the surface of the slope, except if the engineer allows placing sills on slope paving. The safe design bearing value for foundation material, other than rock, under mud sills shall not exceed 2 tons per square foot (191.5 kPa). Unless supporting the excavation for footings adequately with sheeting, place the edge of the falsework sill no closer than 4 feet (1.2 m) from the excavation edge.

- (2) If supporting falsework by mud sills placed on paved, well-compacted slopes of berm fills, then the contractor shall not strut the falsework to columns, unless founding the column on rock or supporting by piling.
- (3) Set falsework at the proper elevation to produce, in conjunction with engineer-approved wedges, shims, or jacks, the specified permanent camber plus a construction camber covering allowance for settlement. Construct slabs and girder spans to provide a permanent camber as the plans show.
- (4) If extending existing concrete bridges, then extend the falsework and forms for the new construction one foot (300 mm) under the edge of the existing structure and make the existing structure bear on the falsework by driving wedges between the falsework and the forms.
- (5) If the plans show, brace and tie the exterior girders supporting bridge decks to the interior girders as necessary to preclude rotation of the exterior girders if supporting the deck overhang by knee braces bearing against the exterior girders.
- (6) If the plans do not show the above requirement, the contractor shall determine the need for any bracing or stabilization necessary to prevent girder rotation and overhang settlement.
- (7) The contractor's responsibility includes obtaining satisfactory results whether or not the plans show a requirement for bracing or stabilizing the exterior girders.
- (8) If building falsework over a stream or lake subject to boating use, construct it to provide ample horizontal and vertical clearance for rowboats and small powerboats to pass. If building falsework over a highway or street used by traffic provide a minimum clearance, unless the plans show otherwise or special provisions specify otherwise, of 22 feet (6.71 m) horizontal and 13 feet 6 inches (4.12 m) vertical. Ensure that no part of the falsework protrudes into the clear areas reserved for water or highway traffic. For signing, conform to plan details or contract provision requirements.

502.3.3 Forms

502.3.3.1 Detailed Plans

- (1) The engineer reviews the details for formwork, bracing, tying, etc., and will not give permission to place concrete until all this work is complete. If the engineer directs, submit detailed plans and computations for forms to the engineer for examination. If these plans and computations do not meet the engineer's approval, make any changes required. Understand that whether or not the engineer requests submission of these plans or concurs in the use of the submitted or corrected plans, the contractor shall remain responsible for obtaining satisfactory results.

502.3.3.2 Design

- (1) Design forms to sustain the pressures resulting from considering all concrete without initial set as a liquid weighing 160 pounds per cubic foot (2570 kg/m³) plus a live load allowance of not less than 10 pounds per square foot (480 Pa) of horizontal projection of forms. Use forms that are substantial and unyielding and designed so that the finished concrete conforms to the proper dimensions and contours. Design forms to account for vibration forces.

502.3.3.3 Erection

- (1) Build forms mortar-tight and sufficiently rigid to prevent distortion from concrete pressure and other loads that occur due to construction operations. Construct and maintain forms to prevent warping and joint openings due to lumber shrinkage, and so they remain true to the lines designated until the concrete hardens sufficiently. Forms shall remain in place for the periods specified below in [502.3.4](#).
- (2) If forms appear unsatisfactory in any way, before or during concrete placement, the engineer will order the work stopped until correction of the defects. If the engineer orders, the contractor shall remove and replace the concrete within the defective area at no expense to the department.

502.3.3.4 Timber Forms

- (1) Use forms for exposed surfaces made of dressed lumber, of uniform thickness and make mortar-tight.
- (2) Fillet the forms with triangular molding chamfer strips at all exposed, sharp corners and at the edges of the concrete. Unless specified otherwise, use triangular molding that measures 3/4 inch (19 mm) on the sides.
- (3) Construct forms for railing, copings, and ornamental work to standards equivalent to first-class millwork. Make all moldings, panel work, and bevel strips, straight and true, with neatly mitered joints, and design so that the finished work is true, sharp, and clean cut. Exercise special care to secure smooth and tight fitting forms, hold the forms rigidly to line and grade, and remove without injuring the concrete.

- (4) In forming copings, offsets, and recesses, give the forms sufficient taper to allow removal without damaging the concrete. The maximum amount of draft shall equal one inch per foot (25 mm per 300 mm).
- (5) Use bolts or rods to hold forms in place. Construct all metal appliances used inside forms to hold them to correct alignment and location so that, after removing the forms, removal of the metal to a depth of at least one inch (25 mm) from the surface of the concrete does not injure the surface. Hold bolts or rods in place by attaching devices to the wales that develop the strength of the rod. Fill cavities left by removing bolts and rods with cement mortar conforming to [502.3.7.1](#) and leave a sound, smooth, and even surface uniform in color. If exposing the completed concrete, use tie rods of a diameter, or fitted with cones, or other means to provide cavities large enough to allow filling and finishing with cement mortar.
- (6) The contractor shall not use spreaders for metal pipe, precast concrete, or rolled sections unless it removes them while placing the concrete.
- (7) Secure forms for exposed surfaces to the studs or uprights with true horizontal joints.
- (8) If reusing forms or form lumber maintain them in clean and good condition as to accuracy, shape, strength, rigidity, tightness and smoothness of surface. Do not reuse any split, warped, bulged, or marred lumber, or use lumber with defects that may produce inferior work.
- (9) If possible, daylight columnar forms at vertical intervals and with sufficient openings to allow free access to forms for inspecting and working the concrete.

502.3.3.5 Metal Forms

- (1) Apply the above specifications for forms, if they are applicable, to metal forms carrying an equivalent loading. Use metal forms thick enough so they remain true to shape. Countersink all bolt and rivet heads in the form face. Use clamps, pins, or other connection devices designed to hold the forms rigidly together and to allow removal without injuring the concrete. The contractor shall not use metal forms that do not present a smooth surface or line up properly. Exercise special care to keep metal forms free from rust, grease, or other foreign matter that tends to discolor concrete.

502.3.3.6 Clean Outs

- (1) For narrow walls and other locations where no reasonable access to the bottom of the forms exists, provide adequate clean-out openings. Ensure forms are clean and entirely free from all chips, dirt, sawdust, nails, wire, and other extraneous matter during concrete placement.

502.3.3.7 Oiling and Wetting

- (1) Oil the inside of forms used for exposed concrete surfaces with a light, clear, paraffin base oil, or treat with other engineer-approved bond-inhibiting materials that will not discolor or injuriously affect the concrete surface. Perform oiling before placing the reinforcement. Thoroughly wet forms with water immediately before placing concrete.

502.3.3.8 Lined Forms

- (1) Use lined forms for the exposed surfaces of all endwalls, substructure units, retaining walls, rigid frames, underside surfaces of all superstructures, except slabs between beams or girders, the outside surfaces of superstructures, and all railing and parapet surfaces.
- (2) Ensure all lined form surfaces completely contact the concrete faced with metal, plywood, composition, or other engineer-approved material to the engineer's satisfaction. Submit samples, specifications, and other pertinent information on these forms to the engineer if requested and secure the engineer's permission to use the contemplated form lining.
- (3) Form lining material shall not bulge, warp or blister, or stain the concrete. Keep the number of pieces of material used line forms to a minimum. Make all splices in form lining material neatly and break joints with the form material.
- (4) The contractor may use forms constructed of metal, plywood, or other engineer-approved material that satisfactorily produces the desired surface finish for the concrete instead of lined forms.

502.3.3.9 Cylindrical Column Forms

- (1) If forming cylindrical columns with fiber pulpboard tubes, use truly cylindrical tubes of uniform diameter and with adequate strength to support the concrete. Ensure that the surfaces of the tube are waterproof with a treated interior surface that prevents adhesion of the tube to the concrete and after finishing, does not leave protruding seams or fins. The tube shall provide a smooth and true column surface, free from discoloration.

502.3.4 Removing Forms and Falsework

502.3.4.1 Removing Forms

- (1) If removing forms under slabs, beams, girders, brackets, and supports, conform to the removal requirements for falsework specified below in 502.3.4.2. The contractor may remove all other forms 12 hours after casting concrete if the concrete is sufficiently set to be self-supporting.
- (2) If forms are an integral part of the falsework, keep them in place until falsework removal. During hot weather, use water, as the engineer directs, to cool the concrete within the forms.
- (3) Remove all forms in a manner causing no injury to the concrete.

502.3.4.2 Removing Falsework

- (1) Do not remove falsework and form supports without the engineer's approval. Remove supports in a manner that allows the concrete to uniformly and gradually take the stresses due to its own mass.
- (2) In determining the removal time of falsework, consider the location and character of the structure, the weather, the materials used in the mix, and all other conditions influencing the concrete setting.
- (3) The engineer may determine when to remove falsework or form supports by using test cylinders or by using the minimum requirements specified below:
 1. If not controlling field operations by cylinder tests, keep falsework supporting concrete in bridges, including slabs, beams, girders, arches or concrete slabs on steel or concrete girders in place according to the minimum requirements for equivalent curing days specified in [502.3.10.1](#). Except do not remove falsework from cast in place bridge slab decks, box girder spans, or deck girder spans until at least 7 days elapse, for deflection control, exclude days that the concrete surface was subjected to temperatures below 40 F (5 C).
 2. If controlling field operations by cylinder tests, remove falsework or form supports, with the engineer's approval, when the tests of cylinders show a concrete compressive strength of not less than 2000 pounds per square inch (13.8 MPa) for spans 12 feet (3.66 m) or less; and not less than 2500 pounds per square inch (17.3 MPa) for spans over 12 feet (3.66 m). Except, do not remove falsework from cast-in-place bridge slab decks, box girder spans, or deck girder spans until at least 7 days elapse, for deflection control; exclude days that the concrete surface was subjected to temperatures below 40 F (5 C).
- (4) Double the length of the horizontal projection of cantilevered portions of piers, abutments, and similar sections for determining span length for falsework removal.
- (5) Test at least 2 cylinders to determine the attained strength of concrete for falsework removal. Use the average test results for the 2 cylinders to determine compliance, except that both cylinders must be no less than 10 percent below the required strength. Cure the cylinders under conditions that at best equal the most unfavorable conditions for concrete sampled that the cylinders represent.
- (6) Remove falsework piles down to at least 24 inches (600 mm) below streambed or finished ground line. Remove temporary mud sills and footings.
- (7) For multiple concrete spans of continuous design, do not remove the falsework from any one span until the concrete in an entire unit of continuous span cures for the required time. If providing a longitudinal joint in the roadway of any one span, do not remove the falsework from any portion of the span until the entire span cures for the required time.

502.3.5 Handling and Placing Concrete

502.3.5.1 General

- (1) Give the engineer sufficient notice of all proposed concrete placement so the engineer can inspect the forms, reinforcement and casting preparations before placing masonry. In general, give this advance notice at least 24 hours before beginning the cast.
- (2) Before placing any concrete in a given pour, have sufficient labor, material, and equipment at the worksite to complete the pour. Use equipment that is adequate for the work and in first-class working order.
- (3) Complete the forming and placing reinforcement before placing the concrete in any unit. Place and rigidly support in the correct position all bar steel reinforcement extending into a subsequent pour before placing the first concrete in a given pour, unless the plans show otherwise. Complete all adjacent pile driving and other operations detrimental to freshly placed concrete before placing concrete.
- (4) Before placing concrete, remove all sawdust, chips, nails, wire, other construction debris, and extraneous matter from the forms interior. Clean the contact surfaces of structural steel members embedded in the placed concrete to ensure they are free from oil, grease, loose rust scale, or other materials that would affect the bond between the concrete and the steel.

- (5) The contractor shall not support construction equipment on reinforcement steel or bar chairs.
- (6) Place the concrete in a manner that avoids segregating the aggregate or displacing the reinforcement. If the engineer finds any concrete section, remove and replace it, as the engineer directs, at no expense to the department.
- (7) Arrange and use chutes, troughs, belts, and pipes as aids in placing concrete so no separation of the concrete ingredients occur. Provide a sufficient number of chutes, troughs, or pipes to carry the concrete up at a uniform level without shifting them. Keep all chutes, troughs, belts, and pipes clean and free from coatings of hardened concrete. Discharge water used for flushing away from the concrete in place.
- (8) If placing concrete in structures, the distance from the discharge ends to the point of deposit for chutes, troughs, pipes, belts, and buckets shall not exceed 4 feet (1.2 m).
- (9) If using conveyor belt systems, equip the belts with suitable hoods or chutes to control the discharge.
- (10) If conveying or placing concrete by pumping, use suitable equipment with adequate capacity for the work. Arrange the equipment so that any resulting vibrations do not damage freshly placed concrete. Operate the pump in a manner that produces a continuous stream of concrete without air pockets. After pumping is complete, if using the concrete remaining in the pipeline, eject it so there is no concrete contamination or ingredients separation. After this operation, thoroughly clean the equipment.
- (11) If placing concrete by pumping, take measures to minimize entrained air loss. The point of discharge from the flexible hose at the end of the boom shall be higher than the lowest point of the flexible hose. If using an extended boom, the contractor may lay part of the flexible hose on the deck. If completely suspending the flexible hose from the boom, tie the discharge end of the flexible hose back toward the end of the rigid boom to form a partial loop. The engineer may approve alternate methods if the contractor can demonstrate that the air loss in the concrete created by the pumping process does not exceed 1.0 percent in any boom orientation.
- (12) The contractor shall not use aluminum pipes, chutes, troughs, spouts, or tremies for pumping, conveying, or placing concrete.
- (13) If placing operations involve placing concrete through the completed forms, as for, piers, columns, and retaining walls over 5 feet (1.5 m) in height, with the exception of cast in place concrete piles and walls less than 10 inches (250 mm) in thickness, deposit all concrete through sheet metal or other engineer-approved pipes. Assemble these pipes in sections to facilitate adjusting outlets to proper heights during pouring operations. The distance from the bottom of these pipes to the point of deposit shall not exceed 4 feet (1.2 m) at any time.
- (14) If using troughs or chutes, extend them down inside the forms, or through holes left in the forms, to within 2 feet (600 mm) of the point of deposit unless they terminate in vertical downspouts that extend to within 4 feet (1.2 m) of the point of deposit. Equip steep chutes with baffle boards or assemble them in short lengths that reverse the direction of movement. The contractor shall not use long chutes for conveying concrete from the mixing plant to the forms.
- (15) Place concrete in continuous horizontal layers approximately 12 inches (300 mm) thick, except that the engineer may allow increasing this thickness to 24 inches (600 mm). Place each layer in a continuous pour and consolidate before the concrete in the preceding layer takes initial set.
- (16) Make construction joints only at locations the plans show, unless the engineer directs otherwise. In case of an emergency, place construction joints at the engineer's direction. Use shear keys or inclined reinforcement at necessary points to transmit shear, or bond the 2 sections together.
- (17) Regulate placing the concrete so that the pressure of the concrete does not exceed that of the form design.
- (18) Take special care to fill each part of the forms by depositing concrete directly as near the final position as possible, to work the coarse aggregate back from the face, and to force the concrete under and around the reinforcement bars without displacing them. Also, try to prevent spattering the forms or reinforcement bars so that the spattered concrete does not dry or harden before incorporating into the mix. Clean foreign material from reinforcement bars before the succeeding pour.
- (19) Remove all removable form spreaders before placing concrete at the spreader elevation.
- (20) Take care to avoid accumulating laitance or foreign matter inside forms, recesses, or corners. Provide openings in forms for removing any accumulations, as the engineer directs.

- (21) After the concrete takes initial set, avoid jarring the forms or placing any strain on the ends of projecting reinforcement.
- (22) Use mechanical vibration to consolidate the concrete for superstructures. Consolidate other concrete for structures by vibrating unless using other methods the engineer finds satisfactory. Use vibrators capable of operating at frequencies sufficient to achieve thorough and uniform consolidation, but at not less than 7000 impulses per minute. Make available at least one spare vibrator, in working order and of sufficient frequency, on the work site before pouring concrete.
- (23) Apply vibration to the freshly deposited concrete by slowly inserting and withdrawing the vibrator. Perform this procedure at enough locations and for as long as necessary to uniformly and thoroughly consolidate the entire weight of fresh concrete without causing aggregate segregation, or forming localized areas of grout.
- (24) Consolidate each concrete layer thoroughly before placing the next layer on top. Ensure that the vibrator penetrates through each successive layer and sufficiently into the preceding layer to uniformly blend the 2 concrete layers together.
- (25) The contractor shall not perform vibration directly to or through the reinforcement of sections or layers that harden so that they are no longer plastic under vibration. The contractor shall not use the vibrator to transport, or to flow, the concrete within the forms to the extent of causing segregation.
- (26) Supplement vibration with as much spading as necessary, to ensure smooth surfaces and dense concrete, along form surfaces and in corners and locations impossible to reach with the vibrator.
- (27) If required to continue mixing, placing, or finishing concrete after daylight hours, employ artificial light at the work site to the engineer's satisfaction.

502.3.5.2 Substructures

- (1) If possible, place concrete for substructures in unwatered foundation pits. The contractor may omit the forms and fill the entire excavation with concrete, if the material type encountered in excavation for structures allows placing concrete for footings wholly or in part without forms, and if the engineer approves.
- (2) Place concrete in columns in one continuous operation unless the engineer specifies or the plans show otherwise. Allow the concrete to set at least 12 hours before placing the concrete in the cap, cross girder, or superstructure.
- (3) If the plans show, ensure the thorough and effective drainage of the filling material behind culverts, retaining walls, and abutments by placing weep holes in conjunction with the construction specified in [206.3.12](#). Discharge the drainage water through the abutment, the wall of the culvert, or through the retaining wall in a manner and at locations that do not cause discoloration of exposed masonry surfaces. Form weep holes and, if necessary, fit with suitable screens or gratings to protect the intake against clogging. Constructing weep holes the plan shows is incidental to the work.
- (4) The contractor shall not place concrete on a frozen foundation.

502.3.5.3 Depositing Concrete Underwater

- (1) Deposit concrete underwater only if the engineer orders, or the plans show, or the contract specifies.
- (2) Provide grade D concrete as specified for concrete in [section 501](#), except use a slump of 5 to 9 inches (125 to 225 mm). For concrete used in seals, the contractor may use up to 40 gallons per cubic yard (200 L/m³) of mixing water.
- (3) For concrete deposited underwater, place it carefully in a compacted weight in its final position using a tremie. The tremie consists of a tube that has a diameter of not less than 10 inches (250 mm) and constructed in sections having flanged couplings fitted with gaskets. The tremie support shall allow free movement of the discharge end over the entire work surface and allow its rapid lowering if necessary to choke off or retard the flow. Keep the discharge end sealed at all times and the tremie tube full to the bottom of the hopper. If dumping a batch into the hopper, raise the tremie slightly, but not out of the concrete at the bottom, until the batch discharges to the bottom of the hopper. Then stop the flow by lowering the tremie. Ensure a continuous uninterrupted flow until the work is complete. The contractor may use a tremie equipped with a suitable mechanical seal or valve at the discharge point instead of the open tube tremie, if the engineer approves of the design, method of operation, and control of the device.
- (4) Exercise special care not to disturb concrete deposited underwater and to maintain still water at the deposit point. The contractor shall not place concrete in running water. Ensure watertight formwork.

- (5) Place the concrete in a manner that precludes developing a cold joint between successive layers or placement stages. Accomplish this by either placing the concrete layers deep enough to accommodate satisfactory tremie operation, while ensuring that the previously layer does not take initial set by pouring at a rate sufficient to raise the concrete level between 1 1/2 to 2 feet (450 to 600 mm) per hour; or by placing the concrete full depth in one continuous operation and completing the work to grade progressively from one end of the cofferdam to the other.
- (6) Design the cofferdam to accommodate appropriate and planned pour rates. The contractor may place the seal concrete by pumping, if the engineer approves.
- (7) The contractor shall not dewater the cofferdam until at least 3 days pass from the time placed and not before the concrete hardens and is strong enough to withstand the hydrostatic pressure.
- (8) After dewatering, remove all laitance or other unsatisfactory material on the top of the seal and underlying the proposed substructure unit by scraping, chipping, or other means.

502.3.5.4 Superstructures

- (1) Except for railings, curbs, parapets, or similar pours, the contractor shall not place concrete in bridge decks if housing is required at time of placement, unless the engineer specifically allows or requires in writing. Except for rigid frame bridges, remove the forms for the substructure units that support any proposed superstructure before placing the superstructure.
- (2) Ensure continuous concrete placement in superstructures between joints the plans show.
- (3) Exercise care to minimize honeycombed concrete. The engineer may require the removal and replacement of all honeycombed concrete at no expense to the department.
- (4) Fill girder pockets in horizontal layers slightly before placing the floor slabs, provided the concrete in girder pockets does not take its initial set before placing the concrete in the slab over the girders.
- (5) The contractor shall not place concrete railings, parapets, curbs, walks, and medians on cast in place structures until the falsework is released for that superstructure unit, provided, that the contractor may place those portions of the railings directly attached to substructure units while the falsework is in place.
- (6) The contractor may form and place concrete railings, parapets, curbs, walks and medians on steel girder, I-beam or pre-stressed girder structures after 48 hours following deck placement, provided it uses no heavy equipment on the deck and it properly cures the deck adjacent to the pours.
- (7) Place floor drains, conduits, expansion joints, and other fittings as the plans show. Place and securely fastened them before placing the concrete.
- (8) Before placing concrete floors on steel superstructures, release the falsework and swing the span free on its supports.

502.3.6 Joints

502.3.6.1 General

- (1) Construction joints are those joints that do not provide for movement of abutting surfaces. Expansion joints are those joints that provide for movement by sliding or by deflection. Contraction joints are those joints that provide for accommodating movement resulting from contraction, and control cracking.
- (2) Place joints only at the locations that the plans show. The contractor shall not omit any joints the plans show, except upon the engineer's written authorization. If constructing joints not as the plans show, but that are required due to emergency, use shear keys or inclined reinforcement at locations necessary to transmit shear, or to bond the 2 sections together.
- (3) The contractor shall not edge joints that have reinforcing steel carried through.
- (4) Conform to the plans for constructing construction, expansion, and contraction joints. Unless the plans show otherwise, make joints normal to the forms. Provide bulkheads for all except horizontal joints. Ensure that joints are true to alignment and uniform in width.
- (5) If the plans show, seal expansion joints with a hot-poured elastic joint sealer, conforming to [502.2.10](#). Seal contraction joints with a non-bituminous joint sealer conforming to [502.2.9](#).

502.3.6.2 Construction Joints

- (1) Form keyed construction joints by inserting and subsequently removing a template. Use a method to insert and remove the template that avoids chipping, breaking, or damaging the concrete.

- (2) If joining fresh concrete to concrete previously set, remove all loose material, laitance, dirt, and foreign matter from the previously set concrete surface and keep the surface saturated with water until the new concrete is placed. Immediately before placing the new concrete, draw all forms tightly against the previously set concrete.

502.3.6.3 Expansion Joints

502.3.6.3.1 Preformed Joint Filler

- (1) Use preformed joint filler conforming to [502.2.10](#), carefully placed, and accurately fit to the adjacent concrete. Take special care to prevent displacing the joint filler during concrete placing and to prevent forming concrete fins under or between the sections of material. Do not assemble a series of small pieces of joint filler to produce a shape that could be cut from a single piece. Edge or chamfer all exposed concrete edges adjacent to preformed fillers, as the plans show.

502.3.6.3.2 Preformed Elastomeric Compression Joint Sealer

- (1) Use preformed elastomeric compression joint sealer conforming to [502.2.8](#) and install in the joint with a lubricant-adhesive.
- (2) Clean all joint faces to ensure they are free of laitance, oils, greases, dirt, free water, and other foreign matter immediately before installing the seal. The engineer will direct the method of cleaning the joints.
- (3) Install the seals, in the properly prepared joint, using tools designed for installing joint seals. Remove and replace any seal damaged during installation with an undamaged seal. Remove and reinstall any seal improperly positioned in the joint at the proper elevation.
- (4) Before placement, cut the seals to the lengths of the joints or as much longer as needed for proper installation. Measure each seal before and after installing as a check against stretch. Remove and reinstall any installed seal showing more than 5 percent stretch.
- (5) Install the seals so they are secure and free from any objectionable curling or twisting in the joint groove. Use a lubricant to facilitate installation and to cover both sides of the seal over the full area in contact with the sides of the joint. The contractor may apply the lubricant to the joint faces, or the seal, or both. Install the seals in a highly compressed state and ensure the top of the seal is below the pavement surface by approximately 1/8 inch (3 mm) but not more than 3/8 inch (10 mm). Install the seal in one piece, without field or factory splicing, for the full length of each transverse joint.
- (6) Observe the manufacturer specified temperature limitations.

502.3.6.3.3 Expansion Device

- (1) Use an expansion device conforming to one of the models the special provisions show.
- (2) Install the steel extrusions with field splices located to match the stage construction. The department will not allow welding in the steel extrusion's internal section where the neoprene extrusion is located.
- (3) Blast clean the steel extrusion's internal section that comes in contact with the neoprene extrusion so that all surfaces are dry, free from dirt, grease, and contaminants before installing the neoprene extrusion and cover or fill this internal section before placing concrete, to prevent concrete from entering.

502.3.6.4 Joint Waterproofing

502.3.6.4.1 Waterstop Method

- (1) Waterproof construction and expansion joints, if the plans show, by installing rubberized membrane or polyvinyl chloride waterstops. For material details, use the requirements for preformed elastomeric compression joint sealer in [502.2.8](#). Make the field splices for rubberized membrane or polyvinyl chloride waterstops watertight. Install rubberized membrane waterstops as specified for rubberized membrane in [516.3.3](#). Install polyvinyl waterstops as the plans show.
- (2) Install waterstops so they do not transfer forces into the concrete embedded in until the concrete is sufficiently strong to withstand that force.

502.3.7 Surface Finish of Concrete

502.3.7.1 General

- (1) After removing forms, remove all metal devices used to tie forms together in a manner that leaves no metal within less than one inch (25 mm) of the concrete surface and does not injure the concrete surface. The contractor shall not burn off rods, bolts, or other metal devices. After removing the ties, roughen the opening and remove all concrete containing any oil.

- (2) Immediately after removing forms, saturate all cavities produced, and all other holes, depressions, and honeycomb spots with water and carefully point with a portland cement and fine aggregate mortar mixed in the same proportions as the concrete being treated and of as dry a consistency as possible to use. For exposed surfaces, add as much white cement as necessary to provide a mortar the approximate color of the concrete. Use mortar in pointing that is not more than one hour old.
- (3) Clean all open joints in the completed work to make them free of mortar and concrete.
- (4) If using insulated forms or if allowed to leave forms in place more than 72 hours, point holes, cavities, depressions, and honeycomb areas and apply a sack rubbed or rubbed surface finish as soon after removing the forms as weather and curing conditions allow.

502.3.7.2 Ordinary Surface Finish

- (1) Unless specified otherwise, provide an ordinary surface finish on all formed surfaces.
- (2) Work the concrete up against all formed surfaces during placement by using engineer-approved concrete vibrators or spading implements. Force all coarse aggregate from the surface, and thoroughly work the mortar against the forms to produce as smooth a finish as possible, free from water pockets, air bubbles, and honeycomb.
- (3) Immediately after form removal, point all tie rod holes, pits, or defects and remove or correct all fins and irregularities. If the engineer determines that the final surface is not satisfactory and that an ordinary surface finish was not provided, apply a rubbed surface finish conforming to 502.3.7.3 to the affected exposed areas. There is no requirement to extend the rubbed surface finish into nondefective areas solely to obtain a uniform texture.

502.3.7.3 Rubbed Surface Finish

- (1) Apply a rubbed surface finish by carefully rubbing the ordinary surface finish with a fine carborundum brick immediately after removing the forms. Begin by moistening the surface with water and then immediately rubbing it with the carborundum brick, using light pressure and a circular motion. Continue rubbing until filling all air holes and small depressions and a thin, uniform coating of mortar is on the surface and until obtaining a smooth surface, free from lumber marks and irregularities.
- (2) The contractor may employ machine methods to produce the rubbed surface finish if the engineer approves.
- (3) Keep rubbed surfaces wet and covered for at least 4 days or cure by applying membrane-curing material as specified in [502.3.8](#).
- (4) Before acceptance, remove all lather, powder, and dust on rubbed surfaces.

502.3.7.4 Float Surface Finish

- (1) Unless specified otherwise, apply a float surface finish to all unformed upper surfaces.
- (2) To provide a float surface finish, place excess material in the forms and remove or strike off the excess with a wooden template, forcing the coarse aggregate below the mortar surface. After striking off the concrete, work the surface thoroughly with a wooden float. Before this last finish sets, lightly stripe all surfaces that are finished this way and exposed in the finished work with a fine brush to remove the surface cement film and leave a fine-grained, smooth, but sanded texture.
- (3) The contractor shall not mortar top surfaces that will receive a float surface finish.

502.3.7.5 Sack Rubbed Surface Finish

- (1) If the plans show, or specifications indicate, provide a sack rubbed finish on concrete surfaces.
- (2) Before applying the sack-rubbed finish fill all tie rod holes and large cavities and remove or correct all fins and irregularities as specified in [502.3.7.1](#) and 502.3.7.2.
- (3) Produce a sack rubbed surface finish by rubbing the concrete surface with a clean rubber float or wad of burlap and mortar. Use mortar made of one part portland cement and 2 parts, by volume, sand passing a No. 16 (1.18 mm) sieve, mixed with sufficient water to provide a consistency equal to that of thick cream. Use the same type and brand cement as used in the concrete. If necessary, blend white cement into the cement to match the surrounding concrete surface.

- (4) Thoroughly wet the surface of the concrete and then perform sack rubbing while the surface is damp but not wet. Thoroughly rub the mortar over the area with a rubber float or wad of burlap, filling all pits. While the mortar is still plastic in the pits, rub the surface with the rubber float or burlap using a dry mix of the above proportions, removing all excess plastic material and placing enough dry material in the pits to stiffen and solidify the mortar, then finish the mortar fillings flush with the surface. At the end of the rubbing, no mortar or material shall remain on the surface other than that within the pits.
- (5) Ensure the completed surface is free of surface voids and blemishes, and is uniform in appearance and texture, except for the difference in texture between the filled voids and the remainder of the surface.

502.3.7.6 Substructures

- (1) Provide an ordinary surface finish for all formed faces of substructure units. Except, give all exposed formed surfaces of parapets or curbs built integrally with substructure units the same surface finish specified for similar work on superstructures in [502.3.7.7](#). Rubbed or special surface finish is not required for any formed faces of substructure units unless the plans or special provisions require, or as specified in [502.3.7.2](#) for applying a rubbed surface finish.
- (2) Strike off and float bent caps, bridge seats, tops of parapet walls supporting a superimposed load, and tops of piers with a wooden float as specified for float surface finish. Before this last finish sets, steel trowel the entire area. If finishing areas to receive bearing plates, secure a true plane at the correct elevation.

502.3.7.7 Superstructures

- (1) Apply a sack rubbed surface finish to all exposed formed surfaces of parapets, railings, posts, walks and curbs and to all exposed side surfaces of superstructures, including the outer face of outside pre-stressed girders as specified in [503.3.2.4](#), unless the special provisions specify otherwise.
- (2) There is no requirement to provide a rubbed surface finish for any formed surface of superstructures, unless the plans or special provisions require it, except if, the engineer determines the sack rubbed finish provided is unsatisfactory, then the contractor shall apply a rubbed surface finish conforming to [502.3.7.3](#) to the affected exposed areas.
- (3) Strike off and float the tops of safety curbs, sidewalks, copings, or curbs that serve as sidewalks in the completed structure with a wooden float as specified for float surface finish. Before this last finish sets, steel trowel these areas and then brush them.

502.3.7.8 Floors

- (1) Prepare the concrete for bridge floors, if and as required in [501.3.2.4.3](#), with a retarding admixture. Deliver the mixed concrete at a uniform rate to provide a continuous placing operation for each pour section. Handle and place the concrete by methods and equipment that minimize segregating the ingredients. Deposit it as closely as possible to its final position without forming piles and so that it requires a minimum of rehandling.
- (2) Immediately after depositing the concrete, consolidate, strike off, screed, and finish it to the required grade, section, and surface tolerance. Uniformly consolidate the concrete by internal vibratory methods as specified in [502.3.5.1](#), except that, the contractor may use a vibratory screed for consolidating and finishing in conjunction with internal vibration. Operate the internal vibrators or the vibratory screed, or both, in a manner that avoids over-vibration.
- (3) Unless the contract specifies otherwise, construct concrete bridge floors with self-propelled machine finishers.
- (4) Use a machine finisher designed for finishing bridge floors. It shall consist of a rigid supporting frame mounted on wheels that ride on removable tracks or rails and is equipped with the necessary screeding apparatus to strike off and finish the concrete to required crown and grade. It shall have one or more power-driven oscillating, rotating or vibratory screeds. The screeds may suspend from the machine either transversely or longitudinally with the bridge centerline, except as required for skew angles of 20 degrees or greater. Use a finishing machine capable of propelling itself both forward and backward to allow repeated passes of the screed in order to correct surface irregularities. Adjust its screed or screeds and operate in manner that finishes the concrete to required grade and crown and requires a minimum of cutting or filling in any subsequent float-finishing operations.

- (5) The contractor shall set the rails or tracks, that the machine finisher rides on, to the required elevation; and ensure they adjust to allow for settlement under load. If the rail supports are located in the concrete, ensure their removal without disturbing the concrete, or partially remove so that no piece remains less than 2 inches (50 mm) below the finished concrete surface. Remove these supports, fill the resulting holes with concrete, and finish flush with the deck concrete before it hardens.
- (6) Ensure the rails or tracks extend beyond each end of the floor or deck sufficiently to support the finishing machine at the correct grade and entirely free of the floor or deck area.
- (7) Finish floor areas inaccessible to machine operation by hand methods.
- (8) On bridge decks supported on prestressed concrete or steel girders and having skew angles of 20 degrees or greater, operate the finishing machine so that its longitudinal axis is within 20 degrees of center line of bearing of the substructure units. Make transverse screeds parallel to the longitudinal axis of the machine.
- (9) If using hand-operated strike-off screeds, design, construct, and operate them to provide the required crown and grade in the finished floor. The contractor may use vibratory or nonvibratory type screeds that operate on forms or temporary guides set and maintained at the required elevation. Use sectioned, temporary guides that remain rigid and unyielding under screed operation and, if located within the pour limits, can be removed as the work progresses. If using vibratory screeds to supplement required internal vibration, operate them so they do not over vibrate the concrete.
- (10) Hand finish gutter lines and areas around floor drains not reached by the templates and finishing equipment to the grade and section needed to insure proper drainage.
- (11) Strike off and remove the laitance from floor areas that will receive concrete for curbs, walks or similar items.
- (12) Following screeding, unless obtaining a satisfactory surface with a self-propelled finishing machine, float finish the surface as specified in [415.3.11.4](#). The contractor may use hand-operated floats conforming to [415.3.1.4](#).
- (13) While the concrete is still plastic and following screeding operations, and float finishing if performed, work all laitance, surplus water, and inert material off the floor and make it smooth. Test for smoothness by dragging the entire floor surface with a 10-foot (3 m) straightedge as specified in [415.3.11.8.1](#) for straightedging concrete pavement. Use bridges to facilitate straightedge operations on pour sections wider than 2 lanes.
- (14) Unless specified otherwise, tine finish the floors of structures with approach pavements designed for speeds of 40 mph (65 km/h) or greater as specified in [415.3.11.6.3](#), except make the tining 1/8 inch (3 mm) in depth and do not perform tining within 12 inches (300 mm) of gutters. The contractor may apply a broom finish, described below, instead of the artificial turf drag finish required before tining. The contractor may perform tining manually, if it obtains a finish satisfactory to the engineer. Perform tining within 20 degrees of the centerline of bearing of the substructure units on bridge decks having skew angles of 20 degrees or greater.
- (15) Unless specified otherwise, provide a turf drag finish on floors of structures with approach pavements designed for speeds of less than 40 mph (65 km/h) as specified in [415.3.11.6.2](#) or provide a broom finish. If providing a broom finish, draw the broom transversely across the full width of the pavement with adjacent strokes slightly overlapping. Perform brooming to produce uniform corrugations and approximately 1/8 inch (3 mm) in depth. Complete brooming before the concrete hardens and this operation tears or roughens the surface. Brooming shall provide a surface free from rough or porous areas, irregularities, and depressions that result from improper broom handling. Furnish brooms of a sufficient quality, size, and construction, and operate them to produce a surface finish the engineer approves. Provided the contractor obtains satisfactory results, the engineer will allow manual brooming instead of mechanical brooming.
- (16) The finished bridge floor shall conform to the surface test specified in [415.3.11.8](#).
- (17) Make available suitable platforms to use, as required, over steel reinforcement projecting from previously placed concrete, during the period necessary for the concrete to achieve sufficient strength to preclude damage from contractor's operations on the unprotected reinforcement.
- (18) Make available adequate bridges, if and as the engineer requires, for inspecting and testing the placed concrete, and furnish bridges, if necessary, to perform work operations that follow the screeding operations.

502.3.8 Curing

502.3.8.1 General

- (1) Maintain adequate moisture throughout the concrete mass to support hydration until the concrete develops sufficient strength to open it to service. Cure all concrete by one or a combination of the following methods:
 1. Impervious coating.
 2. Impervious sheeting.
 3. Continuous wet cure.
 4. Alternate method the engineer approves.
- (2) If the contractor fails to cure concrete as specified here in 502.3.8, the engineer may suspend concrete placement operations.

502.3.8.1.1 Impervious Coating Method

- (1) After finishing operations, and as soon as the free water disappears, spray the concrete surface with a uniform coating of curing compound conforming to curing agents specified in [502.2.6.1](#). Seal moisture in the concrete by applying a continuous water-impermeable film on all exposed concrete surfaces.
- (2) Provide sufficient agitation of pigment within the curing compound during spraying to ensure uniform consistency and dispersion as applied.
- (3) Apply the curing compound with spraying equipment that produces a continuous, uniform film that does not run or sag.
- (4) Apply the curing compound uniformly at a minimum rate of one gallon per 150 square feet (0.27 L/m²). Apply the membrane curing material in 2 applications at the rate of not less than one gallon per 300 square feet (0.13 L/m²).
- (5) If damage to the curing compound coating occurs before the concrete conforms to the opening criteria specified in [502.3.10](#), recoat the affected area immediately. If removing forms before the concrete conforms to the opening criteria specified in [502.3.10](#), coat newly exposed surfaces within 30 minutes after form removal.

502.3.8.1.2 Impervious Sheeting Method

- (1) As soon as the concrete receives a finish and hardens sufficiently to prevent excessive marring, cover all exposed concrete surfaces with one or a combination of the following impervious sheeting materials:
 1. Polyethylene sheeting conforming to the curing agents specified in [502.2.6.3](#).
 2. Polyethylene-coated burlap conforming to the curing agents specified in [502.2.6.4](#). Pre-wet the polyethylene-coated burlap and place with the uncoated side against the concrete.
 3. Insulated curing blankets with an impervious coating, with the engineer's approval.
 4. Alternate impervious sheeting materials, with the engineer's approval.
- (2) Provide sheeting material sufficient to cover all exposed surfaces and edges, with enough excess to hold the material securely in place by weighting or an alternate anchoring method. Provide a minimum of 12 inches (300 mm) overlap between adjacent pieces of sheeting. Place the sheeting material so that it is in direct contact with all exposed concrete surfaces.
- (3) Maintain the sheeting material in place until the concrete conforms to the opening criteria specified in [502.3.10](#). If temporary removal is required, to remove forms or perform other necessary work, re-cover all exposed concrete as quickly as practical, or as the engineer directs.
- (4) If the engineer approves, the contractor may reuse sheeting materials that are in serviceable condition.

502.3.8.1.3 Continuous Wet Cure Method

- (1) As soon as the concrete receives a finish and hardens sufficiently to prevent excessive marring, spray or fog the exposed surfaces of the concrete to keep it moist until the concrete conforms to the opening criteria specified in [502.3.10](#). Apply a layer of thoroughly wetted burlap to protect the surface from the mechanical impact of the spray.

- (2) If the concrete surface shows evidence of erosion by the curing water, the engineer will immediately suspend the spraying or fogging. Remedy the conditions causing erosion or switch to another cure method that does not involve continuous wet cure.
- (3) If ambient temperatures are predicted to fall below 32 F (0 C) within the next 24 hours, suspend continuous wet curing and switch to another curing method.

502.3.8.1.4 Alternate Curing Methods

- (1) If the contractor requests, the engineer may approve using alternate materials or curing methods. Supply technical specifications, test results, or performance records to support its proposed alternative method, if the engineer requests.

502.3.8.2 Curing Requirements

502.3.8.2.1 General

- (1) Do not use reinforcing steel to support or attach covering materials.
- (2) If curing formed concrete by the impervious coating method, apply the first application immediately after form removal and surface finish application. If the surface is dry, wet the concrete thoroughly with water and apply the curing compound just as the surface film of water disappears. Apply the second application as soon as the first application sets.
- (3) Do not apply impervious coating curing material to construction joints, or to surfaces being bonded to other concrete, or to surfaces being waterproofed, or to which applying sealants. Ensure that steel reinforcement, anchors, waterstops, and similar devices are free of compound before placing concrete.
- (4) Do not use the impervious coating method on concrete before applying the required surface finish. Use other allowed curing procedures before applying the surface finish.
- (5) The contractor may delay applying the required surface finish, if the engineer approves, until after completing curing with wetted burlap or polyethylene-coated burlap, in order to allow uniform and continuous finish application. Provide at least 4 hours of an engineer-approved moisture cure to prevent the finish from sanding-out.
- (6) If the structure or any portion of it is enclosed, and artificial heat is provided for protection, this does not waive the above requirements for moisture for curing. The contractor may use steam for heating and to produce an adequate supply of moisture within the enclosure.
- (7) The contractor may leave forms in place instead of using burlap or membrane curing.

502.3.8.2.2 Substructures

- (1) Cure all concrete footings, not backfilled upon form removal, and the exposed surfaces of backfilled footings as specified in [502.3.8.1](#) or by submersion, if the engineer approves. If necessary to remove wetted burlap to allow form setting, keep the exposed concrete surface thoroughly damp.

502.3.8.2.3 Decks

- (1) For structures under 100 feet (30.5 m) in length, cure the concrete in decks and sidewalks for at least 7 days with polyethylene-coated burlap or other coated material conforming to [502.2.6.4](#). As soon as the concrete sets sufficiently to support the covering, place the coated burlap with the coated side up; or perform an initial cure of the concrete by using wetted burlap for at least 12 hours and then apply the coated burlap to a thoroughly wetted concrete surface. Place each strip or sheet of coated burlap so that it overlaps the preceding sheet by at least 12 inches (300 mm). Secure the coated burlap covering in place. Ensure adequate moisture is present on the surface of the floor, wearing surfaces, or sidewalks beneath the curing material for the 7-day curing period.
- (2) For Structures 100 feet (30.5 m) or greater in length, cure the concrete in decks and sidewalks by the following method. Begin curing the horizontal concrete surfaces by fogging within 15 minutes of finishing and tining. Apply the fog or fine water spray so that no water marks result and no mortar washes from the concrete surface. Keep the concrete surface continuously wet by fogging until applying the burlap strips to the finished concrete. Wet the burlap immediately after placement. During the first day, until placing the soaker hose system, keep the burlap continuously wet. Through the remainder of the curing period, keep the burlap continuously wet with soaker hoses hooked up to a continuous water source. Inspect the burlap on a daily basis to ensure that the entire surface is moist. If necessary, alter the soaker hose system as needed to ensure the entire surface is moist. Do not use white polyethylene sheeting or plastic coated burlap blankets. Continue moist curing at least 7 days.

502.3.8.2.4 Parapets

- (1) Cure concrete in the inside faces of railings and parapets by covering with wetted burlap immediately after form removal and surface finish application. Keep the burlap thoroughly wet for at least 4 days; or by covering for the same period with thoroughly wetted polyethylene-coated burlap conforming to [502.2.6.4](#).
- (2) Cure concrete in the outside faces of railings, parapets, exterior girders, and similar parts of the structure by one of the following methods:
 1. Apply impervious coating curing material immediately after removing the forms and applying the required surface finish.
 2. Cover with wetted burlap immediately after form removal and applying the required surface finish and keeping the burlap thoroughly wet for at least 4 days.
 3. Cover for at least 4 days with thoroughly wetted polyethylene-coated burlap conforming to [502.2.6.4](#).
- (3) Secure coverings along all edges to prevent moisture loss.

502.3.9 Cold Weather Protection

502.3.9.1 General

- (1) Maintain the quality of the concrete placed in cold weather. Provide the protection necessary to prevent concrete freezing until it develops sufficient strength to conform to the opening criteria specified in [502.3.10](#). Remove and replace frozen or frost damaged concrete at no expense to the department.
- (2) Unless the engineer directs otherwise, protect all concrete under both of the following conditions:
 1. The air temperature is 40 F (5 C) or less.
 2. The air temperature is predicted to be 40 F (5 C) or less within 24 hours.
- (3) Ensure that forms, reinforcement, base, and subgrade are free of ice, snow, and frost during pouring. If the atmospheric temperature is below 40 F (5 C), preheat the interior surfaces of forms, all reinforcement, and the concrete surface adjacent to the pour to 40 F (5 C) or higher.
- (4) Adjust forms or insulation, as necessary, to control the temperature of the concrete. Unless the engineer allows otherwise, ensure the temperature of the concrete does not exceed 120 F (49 C), or fall below 40 F (5 C) during the protection period.

502.3.9.2 Mixing

- (1) Heat the mixing water, aggregates, or both under both of the following conditions:
 1. The air temperature is 40 F (5 C) or less at the time of mixing or placement.
 2. The air temperature is predicted to be 40 F (5 C) or less within 24 hours following placement.
- (2) During concrete placement, ensure the mixed concrete temperature is not less than 55 F (13 C) or more than 80 F (27 C), unless otherwise directed.
- (3) Do not heat the cement, or add salt or other chemicals to the mix to prevent freezing.

502.3.9.3 Heating

- (1) Protect all exposed concrete surfaces within a heated housing from drying and carbonation throughout the curing period by the impervious coating method or the impervious sheeting method specified in [502.3.8](#).
- (2) If heated housing is required before placing concrete, heat the housing sufficiently before placing the concrete to ensure a temperature of the forms and reinforcing steel of not less than 40 F (5 C). Ensure a reasonably uniform temperature throughout the enclosure.
- (3) If the engineer allows, the contractor may protect footings by completely and continuously submerging in water inside the cofferdam.

502.3.9.4 Temperature Records

- (1) Take temperature readings within the enclosure at necessary times to show the true temperature conditions that the concrete is subjected to. At a minimum, provide high/low thermometers that retain the minimum and maximum temperature readings for each measurement period. Provide facilities suitable to the engineer to verify the temperature inside and outside the insulation, and within the mass of the concrete at various locations in the unit. Make temperature recordings at least every 24-hours. Make outside air temperature recordings at the same time making the recordings within the enclosure. Provide a copy of the temperature record to the engineer at the close of each day's work.

502.3.9.5 Cessation of Heating or Cold Weather Protection

- (1) At the end of the heating or cold weather protection period, gradually reduce the temperature within the enclosure to avoid a sudden temperature change of the new concrete. Make this decrease by loosening the forms and other insulating layers in a manner to allow the whole mass of concrete to gradually approach the outside air temperature at the end of the curing period. Ensure the average rate of decrease does not exceed 5 F (3 C) in any hour, or 40 F (22 C) in any 24-hours, until reaching the outside air temperature. Allow the concrete surface to dry while equalizing the temperatures.

502.3.9.6 Bridge Decks

- (1) Protect concrete in bridge decks as specified for structural masonry, and except for railings, curbs, parapets, and similar pours, according to the following requirements:
 1. Do not place concrete for bridge decks or other superstructure elements when the national weather service forecast for the construction area predicts temperatures to fall below 32 F (0 C) within 24 hours, unless the engineer specifically allows or requires in writing.
 2. Protect the underside of the deck by housing and heating when the national weather service forecast for the construction area predicts temperatures to fall below 20 F (-7 C) during the cold weather protection period.

502.3.10 Applying Loads to Concrete

502.3.10.1 Opening to Service

502.3.10.1.1 General

- (1) Maintain moisture, temperature, and physical protection for concrete until it develops sufficient strength to open it to service. The engineer will use the same criteria to allow the opening of all structural masonry concrete items to service as is used to allow the opening of bridge superstructures to traffic.
- (2) The engineer will allow the contractor to open bridge superstructures or other structural masonry items to construction and public traffic when the concrete attains a verified compressive strength of 3500 pounds per square inch (24.2 MPa). Without compressive strength information, the engineer may allow the contractor to open the affected structural masonry after the following minimum times as adjusted for concrete surface temperature.

APPLICATION	EQUIVALENT CURING DAYS
High early strength concrete	4
General purpose concrete: grades A and D	5
General purpose concrete: grades A-FA, A-S, A-T, A-IS, and A-IP	7

- (3) The equivalent curing day is based on a daily average concrete surface temperature of 60 F (16 C). Calculate the daily average concrete surface temperature by taking the average of the high and low temperatures at the least favorable location of the affected concrete unit, as verified by the project engineer, for each day. If this daily average concrete surface temperature falls below 60 F (16 C), then equivalent curing days accumulate at a reduced rate. Use the following guidelines to calculate equivalent curing days; for a daily average concrete surface temperature of:
 1. 60 F (16 C) or more; accumulate one equivalent curing day per calendar day.
 2. 40 to less than 60 F (4 to <16 C); accumulate 0.6 equivalent curing day per calendar day.
 3. Less than 40 F (4 C); no curing credit is accumulated.

502.3.10.1.2 Exceptions

502.3.10.1.2.1 General

- (1) The contractor may conduct construction operations on concrete not conforming to these opening criteria as specified in [502.3.10.1.2.2](#) and [502.3.10.1.2.3](#). The engineer may suspend or delay operations that injure the surface or otherwise damage the concrete. Clean the surface before allowing any traffic to use the structure.

502.3.10.1.2.2 Substructures

- (1) If placing footings on seals, the contractor may set the footing forms and place the concrete immediately after dewatering the cofferdam and preparing the surface of the seal. Unless the engineer directs otherwise, the contractor may set the column and wall forms on the day after placing the concrete in the footing; and may place the concrete in columns and walls after the concrete footing for the column or wall cures for at least 24 hours over 40 degrees F (4C).

- (2) Do not apply any load of the superstructure, or any dead load, except as specified in [502.3.10.1.2.2\(1\)](#), to concrete substructure units until the concrete in the unit cures for at least 48 hours under favorable conditions. Do not apply loads to the beams of open-type substructure units until after the required falsework support period.

502.3.10.1.2.3 Superstructures

- (1) After the concrete cures sufficiently, the contractor may, with the engineer's approval, apply loads to decks that result from storing small articles, and operating concrete buggies and other necessary light equipment, if applied in a manner that causes no injury to the concrete.
- (2) If the deck concrete conforms to [502.3.10.1.1\(2\)](#); the contractor may operate hauling equipment, as necessary to perform subsequent pours, on the structure 24 hours after placing curbs or parapets. For the first 24 hours limit loadings applied directly over the exterior girders to those imposed during concrete unloading operations.

502.3.10.1.3 Opening Strength

502.3.10.1.3.1 General

- (1) Determine opening strength and provide the engineer with the information required to verify that strength by one or a combination of the following methods:
 - 1. Compressive strength testing of cylinders.
 - 2. Maturity method.
- (2) The resulting opening strength, when the engineer verifies, will apply to concrete on the same project conforming to the following criteria:
 - 1. Of the same mix design as the test location.
 - 2. Cured under similar or more desirable conditions.
 - 3. Placed on or before the test location.
- (3) If both direct compressive strength test results and maturity data are not available, the engineer may estimate compressive strength based on test results of concrete of the same mix design placed adjacent to and under similar conditions on the same project.

502.3.10.1.3.2 Compressive Strength Testing of Cylinders

- (1) Submit the compressive strength test results to the engineer for verification. Compute the opening strength as the average of compressive strength test results for 2 cylinders. If the strength of a cylinder is less than 90 percent of the required strength, the engineer will reject the resulting average. Field cure cylinders under conditions similar to those prevailing for the structural masonry unit they represent. Fabricate cylinders according to AASHTO T 23 and test the cylinders according to AASHTO T 22.

502.3.10.1.3.3 Maturity Method

- (1) Submit the maturity test results to the engineer for verification. Determine the opening strength from the maturity of the in-place concrete, according to ASTM C1074, using the temperature-time factor method with a 32 F (0 C) datum temperature. Provide the engineer with a strength/maturity calibration curve based either on laboratory developed strength results, or on strength results from structural masonry units incorporated in the project. Develop a new strength/maturity calibration curve every time the mix design changes.

502.3.11 Name Plates

- (1) Furnish and install nameplates as specified in [506.2.4](#).
- (2) Furnish one nameplate and place on each structure at the location the plans show.
- (3) Rigidly attach these plates to concrete structures by using 2 lugs at least 3 inches (75 mm) long cast integral with the plate. Imbed or epoxy the plate lugs in the concrete with the outer face of the border flush with the face of the concrete.
- (4) Permanent plates or markers, other than the nameplate described above, and specified benchmarks, are prohibited on any structure, unless the engineer directs otherwise.

502.3.12 Bridge Seat Protection

- (1) Unless the contract specifies otherwise, apply a mopping of epoxy to the top surfaces of all abutments and any piers beneath transverse joints.
- (2) Use the type of epoxy resin the manufacturer recommends for sealing exterior concrete surfaces, subject to the engineer's approval.
- (3) Apply the epoxy before placing bearing pads or plates and before erecting the superstructure, unless the engineer directs otherwise.
- (4) The contractor shall not apply resin in wet weather, or if the surface temperature of the concrete is below 60 F (16 C) unless the engineer specifically allows.
- (5) If applying resin, ensure the concrete surface is dry, thoroughly clean, and free from dust or other loose material.
- (6) Furnish a 2-part epoxy resin system. Combine immediately before use and apply according to the manufacturer's written instructions. If no application rate is recommended, apply the epoxy at approximately one gallon per 100 square feet (4 L/10 m²).

502.3.13 Protective Surface Treatment

- (1) Furnish and apply a protective surface treatment to the entire top surface of the bridge deck, curb, including vertical face, median or sidewalk surfaces and the inside faces of concrete parapets or railings.
- (2) Apply this treatment to a clean, dry surface, free of dust or loose particles. Immediately before applying the compound, direct an air blast over the surface to remove all dust.
- (3) Apply this treatment after the curing period expires. Apply this treatment according to the manufacturer's recommendations, except ensure the concrete is surface dry for a minimum of one day before applying the surface protection.
- (4) Clean the interior of the application equipment before filling with treatment compound. Complete this work as soon after completing the structure, before opening to traffic, and before suspending work for the winter as possible.
- (5) Apply gray-pigmented anti-spalling compound to the inside face of each parapet.
- (6) The contractor shall not remove protective surface treatment from areas where applying pavement markings.

502.3.14 Masonry Anchors

- (1) Furnish and install masonry anchors as the plans show and specified below.
- (2) Drill holes for type L anchors and type S adhesive anchors with a rotary percussion drill. Drill holes for mechanical wedge anchors type S with a non-percussion type rotary drill. Remove all debris from completed drilled holes by flushing with water or air.

502.3.14.1 Type L Anchors

- (1) Under the Masonry Anchors Type L bid item, drill holes, furnish and place adhesive materials and place reinforcing bars of the length and bar size the plans show.
- (2) Install anchors according to the manufacturer's recommendations. Fill holes not completely filled with adhesive with cement or an engineer-approved grout.
- (3) Select type L masonry anchors from the department's approved products list. Install to develop the ultimate strength of the bar unless plans show otherwise.

502.3.14.2 Type S Anchors

- (1) Under the Masonry Anchors Type S bid item, drill holes and provide either mechanical wedge or adhesive anchors of the type and size the plans show.
- (2) Provide anchors that develop the pullout strength the plans show. When the plans show using reinforcing bars in type S anchors, those bars shall conform to [505.2.3](#) for high strength bar steel reinforcement.
- (3) As the plans show, provide anchors, bolts, studs, nuts, and washers; either hot-dipped or mechanically zinc coated according to AASHTO M 232 or AASHTO M 298, respectively; or made of stainless steel.

502.3.15 Clear Protective Coating

- (1) Furnish and apply a clear protective coating to specified areas of the substructure.
- (2) Apply the coating to the concrete surface before erecting structural steel. The contractor shall not apply coating at temperatures lower than the manufacturer recommends.
- (3) Clean the exposed vertical surfaces of the piers, and the front face of the abutments including the backwalls and the ends of the body wall to remove dust and dirt.
- (4) Apply the coating to these areas by brush or roller to give a smooth coating, completely covering the concrete. Apply the coating at the rate of one gallon per 200 square feet (4 L/20 m²). If the coating runs or sags when applied in one coat, apply the material in 2 approximately equal coats of thickness. Apply the second coat within 10 minutes of the first.
- (5) If, because of weather conditions, the contractor cannot apply coating to the substructure before starting steel erection, protect the above-mentioned areas from staining until applying the coating. Obtain the engineer's approval for the method of temporary protection.

502.4 Measurement

502.4.1 General

- (1) The department will measure the quantities of the various bid items that constitute the completed and accepted structure according to the contract provision for those bid items, in the units provided. All work included in the scope of the contract, but not listed as bid items in the proposal are incidental to the cost of the work.

502.4.2 Concrete for Bridges

- (1) The department will measure the Concrete Masonry Bridges bid items by the cubic yard acceptably completed. The department will not measure work or material for forms, falsework, cofferdams, unless specified otherwise, pumping, bracing or other incidentals necessary to complete the work as required in these specifications.
- (2) If measuring floor slabs, the department will deduct the volume of the flanges of I-beams and precast concrete beams projecting into concrete floor slabs from the volume of the floor slab.
- (3) The department will deduct from the quantity of concrete, as computed above, the actual volume displaced by the projection of cast-in-place concrete piling into the footing, pile cap, or abutment; and 0.8 cubic foot (0.02 m³) of volume for each linear foot (300 mm) of timber piling projecting into the footing, pile cap, or abutment. The department will measure this net quantity for payment.
- (4) If the contractor pours footings wholly, or in part without forms, the department will only measure material placed within the footing dimensions the plans show.

502.4.3 Concrete for Seals

- (1) The department will measure Concrete Masonry Seal by cubic yard acceptably completed. The measured quantity equals the sum of cubic yards of concrete incorporated in the work according to [502.3.5.3](#), if called for in the contract or ordered by the engineer.
- (2) The department will base measurements and computations of quantity of accepted work on the dimensions of the area and thickness of the seal the plans show, or the engineer orders. The department will deduct the volume displaced by piles, if any, from this quantity and the department will measure this net quantity for payment. If using cast in place concrete piling, deduct the actual volume displaced by the piling; and in the case of timber piling, deduct the quantity based on 0.8 cubic foot (0.02 m³) of volume for each linear foot (300 mm) of piling projecting into or through the seal.

502.4.4 Preformed Elastomeric Compression Joint Sealers

- (1) The department will measure the Compression Joint Sealer Preformed Elastomeric bid items by the linear foot acceptably completed, measured along the centerline of the joint.

502.4.5 Expansion Devices

- (1) The department will measure the Expansion Device bid items as a single lump sum unit for each expansion device acceptably completed.

502.4.6 Protective Surface Treatments

- (1) The department will measure Protective Surface Treatment by the square yard acceptably completed. The quantity measured shall equal the actual area of bridge deck and appurtenances treated.

502.4.7 Masonry Anchors

- (1) The department will measure the Masonry Anchors bid items as each individual unit acceptably completed.

502.4.8 Clear Protective Coatings

- (1) The department will measure Protective Coating Clear by the gallon acceptably completed. The quantity measured equals the actual number of gallons used to treat the abutments and piers.

502.5 Payment

502.5.1 General

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
502.0100	Concrete Masonry Bridges	CY
502.0200	Concrete Masonry Bridges HES	CY
502.1100	Concrete Masonry Seal	CY
502.2000	Compression Joint Sealer Preformed Elastomeric (width)	LF
502.3100	Expansion Device (structure)	LS
502.3200	Protective Surface Treatment	SY
502.5000 - 5099	Masonry Anchors (type) (bar)	EACH
502.6100 - 6199	Masonry Anchors (type) (inch)	EACH
502.6500	Protective Coating Clear	GAL

- (2) Perform miscellaneous work that the plans show or the contract specifies, but not listed as bid items, as a part of and included in the contract price for other bid items.

502.5.2 Concrete for Bridges

- (1) Payment for the Concrete Masonry Bridges bid items is full compensation for providing forms and falsework; for placing, finishing, curing, protecting, and heating concrete; for measuring concrete opening strength, including fabricating and testing cylinders, and evaluating maturity; for treating joints, including sealing, providing preformed joint filler and waterproofing; for providing bridge seat protection; and for providing nameplates.
- (2) If the contractor pours footings wholly, or in part without forms, the department will only pay for material placed within the footing dimensions the plans show.
- (3) If the engineer allows the contractor to substitute high early strength concrete to expedite the work as allowed under [502.2.2](#), the contractor will bear the additional costs associated with that substitution.

502.5.3 Concrete for Seals

- (1) Payment for Concrete Masonry Seal is full compensation for providing concrete seals including all forms, placing, curing, protecting, and pumping.
- (2) If the contract does not contain the Concrete Masonry Seal bid item and the engineer orders this work, the department will pay for this work as extra work.

502.5.4 Preformed Elastomeric Compression Joint Sealers

- (1) Payment for the Compression Joint Sealer Preformed Elastomeric bid items is full compensation for providing the seal, including lubricant-adhesive.

502.5.5 Expansion Devices

- (1) Payment for the Expansion Device bid items is full compensation for providing the device.

502.5.6 Protective Surface Treatments

- (1) Payment for Protective Surface Treatment is full compensation for providing the treatment; including preparing and cleaning all surfaces.

502.5.7 Masonry Anchors

502.5.7.1 Type L Anchors

- (1) Payment for the Masonry Anchors Type L bid items is full compensation for drilling holes; for providing adhesive; and for placing the reinforcing dowel bars.
- (2) The department will pay separately for reinforcing bars under the appropriate Bar Steel Reinforcement HS bid item as specified in [505.5](#).

502.5.7.2 Type S Anchors

- (1) Payment for the Masonry Anchors Type S bid items is full compensation for providing mechanical wedge anchors or adhesive anchors, including bolts, studs, nuts, washers and incidentals; for drilling holes; and for installing the anchors and necessary hardware.
- (2) If the plans show using reinforcing bars in type S anchors, the department will pay separately for those bars under the appropriate Bar Steel Reinforcement HS or Bar Steel Reinforcement HS Coated bid item as specified in [505.5](#).

502.5.8 Clear Protective Coatings

- (1) Payment for Protective Coating Clear is full compensation for providing the coating, including temporary protection, and for preparing and cleaning all surfaces.

SECTION 503 PRESTRESSED CONCRETE MEMBERS

503.1 Description

- (1) This section describes fabricating, furnishing, transporting, and erecting prestressed concrete girders, or other prestressed concrete members.
- (2) These specifications provide for prestressing concrete members by the pretensioning method. In this method, stress the reinforcing tendons initially, then place and cure the concrete and release the stress from the anchorages to the concrete after developing specified concrete strength.

503.2 Materials

503.2.1 General

- (1) Furnish materials conforming to the following:
Bar steel reinforcement..... [section 505](#)
- (2) Galvanize, epoxy coat, or furnish non-ferrous materials for all hardware incorporated into the finished structure.

503.2.2 Concrete

- (1) Furnish concrete as specified in [section 501](#). If the design ultimate stress, the plans show as f'_c , is 8000 pounds per square inch (55.2 MPa) or higher for a prestressed concrete I-type girder, extend all 28-day strength requirements for that girder within section 503 to 56 days.
- (2) Ensure concrete attains a minimum 28-day compressive strength of 6000 pounds per square inch (41 400 kPa) for prestressed I-type girders, and 5000 pounds per square inch (34 500 kPa) for prestressed slab and box-type girders. Base all tests on 6 inch by 12-inch (150 mm by 300 mm) cylinders, or 4 inch by 8-inch (100 mm by 200 mm) cylinders, provided the engineer develops and approves a correlation factor. Mold concrete cylinders in suitable steel or plastic molds. Cure concrete cylinders according to AASHTO T 23, except cure the cylinders with the member until release strength is obtained, then cure the cylinders according to AASHTO T 23. Maintain all laboratory facilities and equipment according to AASHTO M 201. Make 3 cylinders for each line of prestressed members poured and test each cylinder according to AASHTO T 22. Calibrate cylinder-testing equipment at least annually according to AASHTO T 67. Average the strengths of the 2 cylinders with the highest test results for each line and use the average to determine compliance with the 28-day strength requirement. Ensure that neither of the 2 cylinders with the highest test results has a strength less than 10 percent below the required strength.
- (3) Instead of the above acceptance procedure, the engineer will allow early acceptance of the prestressed units, before the 28-day test, if 2 successive laboratory tests on standard test specimens, cured continuously with and in the same manner as the units, indicate compressive strength in excess of the required 28-day strength. Test the 28-day strength cylinders and record the results to maintain continuity of the contractor's quality control records.
- (4) The contractor shall make and test the cylinders and make available to the engineer all information relating to the making and testing of cylinders. Notify the engineer immediately if concrete cylinder compressive strengths are less than the required 28-day strength. Keep neatly documented records of all cylinder testing on the day of the test and make them available to the engineer. Provide copies of the tests to the engineer by contract completion.
- (5) Furnish prestressed concrete members cast from air entrained concrete, except I-type girders may use non-air-entrained concrete. Use type I, IS, I(SM), IP, II, or III cement. The contractor may replace up to 30 percent of type I, II, or III portland cement with an equal weight of fly ash conforming to [501.2.6](#) or slag conforming to [501.2.7](#). Use only one source and replacement rate for work under a single bid item. Use a department-approved air entraining admixture conforming to [501.2.2](#) for air entrained concrete. Use only size No. 1 coarse aggregate conforming to [501.2.5.4](#).
- (6) The contractor shall determine proportions for the mix within the following limitations:
Water cement ratio not greater than 0.45^[1]
Cement content, pounds per cubic yard (kg/m³) of concrete 610-705 (362-475)
Air content of concrete, except in prestressed I-type girders, Percent maximum 3.5-6.0
Air Content of concrete in prestressed I-type girders, Percent maximum 6.0
Slump of mixed concrete, maximum..... 4 inches (100 mm)^[3]

- (7) Instead of the above mix proportions, the contractor may incorporate, in a satisfactory manner, an department-approved high range water reducing admixture conforming to ASTM C-494, type G^[2] and use the following mix proportions in producing concrete for prestressed concrete I-type girders.
- (8) The contractor shall determine proportions for the mix within the following limitations:
- | | |
|---|----------------------------------|
| Water cement ratio | 0.25 - 0.45 ^[1] |
| Cement content, pounds per cubic yards (kg/m ³) of concrete | 610-705 (362-475) |
| Air content of concrete, percent maximum | 6.0 |
| Slump of mixed concrete, maximum..... | 7 inches (175 mm) ^[3] |
- ^[1] The water cement ratio for this purpose equals the weight of the total added water plus the aggregate free water, divided by the weight of the cement plus the fly ash or slag (if used in the mixture).
- ^[2] Instead of a type G admixture, the contractor may use type F and type D admixtures in combination in order to attain results of Type G admixture.
- ^[3] Proportion the mix to provide a concrete of uniform quality and consistency with a slump no greater than necessary for proper placement and compaction.
- (9) If the mix does not contain a high range water reducer admixture, use a department-approved set retarding admixture as specified in [501.2.3.2](#) at the recommended rate if the ambient air temperature is 70 F (21 C) or higher. The contractor may use it if the ambient air temperature is less than 70 F (21 C).
- (10) The contractor shall not add more admixtures or water after mixing is complete.
- (11) Use admixtures that do not have significant chlorides or chlorides added during manufacture.
- (12) Use admixtures that are compatible with all ingredients of the concrete mixture.

503.2.3 Pretensioning Reinforcement

- (1) Use high tensile strength, 7-wire strands of the nominal diameter the plans show and conforming to ASTM A 416, grade 270.

503.2.4 Plant Certification

- (1) Obtain all prestressed concrete members from fabrication plants that comply with the department's plant certification program for fabrication of prestressed concrete members, unless the engineer agrees to accept these items according to the alternate procedures set forth in the department's plant certification program.

503.3 Construction

503.3.1 Stressing Procedure

- (1) Ensure all the strands of a pretensioned girder are free from kinks or twists before starting tensioning operations. Ensure no strand unwinds more than one turn after starting tensioning operations. Tension all the strands 1500 pounds (6.7 kN) each before starting elongation readings, or as the contractor determines; however, the contractor shall not use an initial load greater than 4000 pounds (17.7 kN). This initial tension in any strand shall not vary by more than 5 percent. Use equipment to produce the initial tensioning load that provides a means of accurately measuring the force. If applying the initial tensioning load by pressure jacks, equip them with a proper gaging system for the initial force.
- (2) If tensioning draped pretensioned strands in a horizontal position, tension them to a less than required the design stress so that the increased strain from jacking the drape in the strands results in a stress equal to the required design stress.
- (3) If tensioning the draped strands in their draped position, support them by rollers at points of change in direction. Ensure the hold-up rollers between girders and at the ends of the end girders have either bronze bushings or roller bearings, and are well lubricated. Use free running rollers at the hold-down points that produce minimal friction. If stressing from one end results in a difference of more than 5 percent between the load calculated from elongation and the gauge load then tension draped strands from both ends. The sum of elongation at both ends shall agree within 5 percent of that indicated by the jack gauges.
- (4) Provide to the contractor's project file details showing number, spacing, and method of draping pretensioned strands.

- (5) The department will allow one splice per pretensioning strand provided the splices are positioned so only one splice occurs within a member. Ensure that spliced strands have the same twist or lay. Make allowance for splice slippage in computing strand elongation.
- (6) The engineer may accept failure of one wire in a 7-wire pretensioning strand if it attains 85 percent of the required tension load before failure, and the failed wire constitutes not more than 2 percent of the total area of strands in an individual beam or girder.
- (7) If using a jacking system equipped with an automatic release valve that closes if the required prestressing force is reached, there is no requirement to measure strand elongation for all horizontal strands; however, this measurement is required for the first and last strand tensioned and for at least 10 percent of the remaining strands. If performing elongation computations, take into account strand anchorage slippage, horizontal movement of abutments, and any change in temperature of the prestressing steel between tensioning and when concrete takes its initial set, if this change is expected to exceed 30 F (17 C).
- (8) Equip all prestressing systems with accurately calibrated gauges for measuring the loads produced. Ensure all gauges are accurate to within 2 percent and are equipped with a gauge dial read to the nearest 250 pounds (1000 N) of prestressing force. Use a department-approved testing laboratory to calibrate the gauge, and furnish a certified calibration curve for each gauge. If gauges do not read loads directly in pounds (N), provide a chart tabulated in increments of at least 250 pounds (1000 N) for converting the readings to pounds (N). Calibrate the gauges with the gauges in place on the jacking system, completely assembled in the manner used in the prestressing operation.
- (9) For gaging, use loads between 1/4 and 3/4 of the total graduated capacity of the gauge, unless calibration data clearly establish consistent accuracy over a wider range.
- (10) Re-calibrate gaging devices at least once a year; however, if the gaging system gives erratic results, or if the gauge and elongation measurements indicate significantly different stresses, then re-calibrate the jack and the gauges.
- (11) Measure the stress induced in the prestressing element by both jacking gauge pressure and by elongation of the prestressing steel. If these measurements differ, use the gauge pressure to indicate the true stress in the prestressing steel. There is an allowable master tolerance of +/- 5 percent between the actual gauge pressure and elongation and the calculated value of each. Additionally, there is a more restrictive 5 percent tolerance for algebraic comparison of the variation of gauge pressures to the variation of elongations. If the difference between gauge pressure and elongation exceeds 5 percent, carefully check the entire operation, determine, and correct the source of error before proceeding further.
- (12) Mark each anchor (dead, live, and splice) and visually check for slippage in excess of that assumed in the calculations. Perform random measured checks.
- (13) During prestressing operations, provide the safety measures and means necessary to prevent accidents in the event the prestressing steel, hold down devices, abutments, and beds break, or the grips slip.
- (14) Tension the prestressing elements to provide the required prestress the plans show.
- (15) Perform transfer of prestress to concrete after the concrete develops the minimum required strength for transfer determined by the test cylinders.
- (16) Use the minimum required concrete strength at transfer of prestress that the plans show.

503.3.1.1 Placing and Fastening Steel

- (1) Place all steel units in the position the plans show and hold firmly during concrete placing and setting as specified in [505.3](#).
- (2) Maintain distances from the forms by using stays, ties, hangers, or other engineer-approved supports. Separate layers of units by suitable devices. The contractor shall not leave wood blocks in the concrete.
- (3) The contractor may prefabricate ASTM A706 grade 60 (420) or ASTM A615 grade 40 (300) reinforcement bars into cages by welding. The contractor shall not undercut bars by more than 5 percent of their diameter.
- (4) Position wires, wire groups, parallel-lay cables, and any other prestressing elements, correctly in the enclosures. Provide suitable horizontal and vertical spacers, if required, to hold the wires in true position in the enclosures.
- (5) Ensure that all prestressing steel is free of dirt, grease, wax, scale, rust, oil, or other foreign material that may prevent bonding between the steel and the concrete.

503.3.2 Concrete Operations

503.3.2.1 Placing Concrete

- (1) Handle and place the concrete as specified in [section 502](#), except as specified otherwise below.
- (2) Place concrete for I-type girders, up to and including 54 inches (1370 mm) in depth, in at least 2 continuous horizontal layers; and for I-type girders over 54 inches (1370 mm) in depth, place in at least 3 layers. For 2-layer placement, make the layers approximately equal in depth. For 3-layer placement, the first layer shall extend not less than 2 inches (50 mm) above the junction of the bottom flange fillet and the web. Not more than one hour shall elapse between placing successive layers of concrete in any one girder.
- (3) Vibrate the concrete for the girders internally, or externally, or both, to achieve proper consolidation. Perform vibrating in a manner that avoids displacing reinforcing, conduits, or wires.

503.3.2.1.1 Tolerances

- (1) Cast prestressed concrete members to plan dimensions within the following applicable tolerances:

PRESTRESSED CONCRETE I-TYPE GIRDERS

Depth of the flange, web, and fillets.....	+/- 1/4" (6 mm)
Depth overall	+1/2" to -1/4" (+13 to -6 mm)
Width of flanges and fillets	+3/8" to -1/4" (+10 to -6 mm)
Width of web.....	+3/8" to -1/4" (+10 to -6 mm)
Length of beam.....	+/- 1/8" (3 mm) per 10' (3 m), up to a max of +/- 3/4" (19 mm)
Deviation of exposed beam ends from square	
Horizontally	+/- 1/4" (6 mm)
Vertically	+/- 1/8" (3 mm) per foot (300 mm) of beam depth
Side inserts, spacing between centers and from centers to beam ends	+/- 1/4" (6 mm)
Bearing plates, spacing between centers	max of +/- 1/8" (3 mm) per 10' (3 m), or +/- 1/2" (13 mm)
Bearing plates, spacing from centers to beam ends	+/- 1/4" (6 mm)
Bearing plate or bearing area, deviation from plane	+/- 1/16" (2 mm)
Stirrup bars, projection above top of beam	+1/4" to -3/4" (+6 to -19 mm)
Stirrup bars, longitudinal spacing.....	+/- 1" (25 mm)
End of stirrup bars from end of beam	2" (50 mm) or less
Horizontal alignment, deviation from a straight line, "sweep"	1/8" (3 mm) per 10' (3 m) of member length
Camber, differential between adjacent beams.....	1/8" (3 mm) per 10' (3 m) of span up to a max of 1" (25 mm)
Center of gravity of draped strand group	+/- 1/4" (6 mm)
Center of gravity of draped strand group at end of beam	+/- 1/2" (13 mm)
Position of hold-down points for draped strands	+/- 6" (150 mm)
Position of handling devices	+/- 6" (150 mm)

PRESTRESSED CONCRETE BOX AND SLAB-TYPE GIRDERS

Depth of top slab.....	+/- 1/2" (13 mm)
Depth of bottom slab.....	+/- 1/2" (13 mm)
Depth overall	+/- 1/4" (6 mm)
Width of web.....	+/- 3/8" (10 mm)
Width overall.....	+/- 1/4" (6 mm)
Length.....	max of +/-1/8" (3 mm) per 10' (3 m) or +/- 3/4" (19 mm)
Square ends, deviation from square	+/- 1/2" (13 mm)
Skew ends, deviation from designated skew	
Skew angle 30 degrees or less	+/- 1/4" (6 mm)
Skew angle over 30 degrees.....	+/- 1/2" (13 mm)
Beam seat bearing area, variation from plane surface when tested with a straightedge	
Through middle half of member	+/- 1/16" (2 mm)
Horizontal alignment, deviation from a straight line, defined as sweep	
Lengths to 40 feet	1/4" (6 mm)

Lengths 40 feet to 60 feet	3/8" (10 mm)
Lengths over 60 feet	1/2" (13 mm)
Dowel tubes, spacing between centers and from centers to member ends and sides.....	+/- 1/2" (13 mm)
Tie rod tubes, spacing between centers and from centers to member ends.....	+/- 1/2" (13 mm)
Tie rod tubes and dowel tubes, spacing from centers to beam bottoms	+/- 3/8" (10 mm)
Total width of deck.....	theoretical width +1/2" (13 mm) per joint
Camber, differential between adjacent units.....	1/2" (13 mm) max
Camber, differential between high and low members in the same span.....	1" (25 mm) max
Side inserts, positioning.....	Same as for I-type girders
Stirrup bars, positioning.....	Same as for I-type girders
Tendons, positioning.....	Same as for I-type girders
Handling devices, positioning	Same as for I-type girders

503.3.2.2 Curing

- (1) Steam cure concrete members as specified below or cure by other methods identified by the contractor's fabrication quality control plan. Protect the surfaces of members exposed during curing from moisture loss until release strength is obtained. The contractor shall not use curing compound for this purpose.

503.3.2.2.1 Steam Curing

- (1) If steam curing, enclose the concrete member in a chamber or enclosure, with at least 12 inches (300 mm) between the member and the enclosure. If using tarpaulins for enclosures, use at least 2 layers and arrange them to form a tight enclosure that leaks as little steam as possible. Use low-pressure steam and do not allow steam jets to spray directly on the concrete or on the forms. Maintain the relative humidity at approximately 100 percent within the enclosure.
- (2) Maintain the concrete temperature at or near the pouring temperature until the initial set, according to AASHTO T 197, before allowing the temperature to rise. The rate of temperature rise next to the concrete shall not exceed 40 F (22 C) per hour.
- (3) Inside the enclosure, during curing maintain the temperature between 50 F (10 C) and 160 F (71 C). The temperature next to the concrete in different locations within the housing shall not vary more than 20 F (12 C) at any time.
- (4) Place a minimum of 3 engineer-approved continuous recording thermometers in each line. Provide the engineer with complete temperature record charts for the curing period, including the heat-up and cool-down times. If the temperature records indicate that steam control produces rates or temperatures that do not conform to those specified, modify procedures to obtain specified results.
- (5) Continue steam curing until the concrete develops the required strength for transfer of prestress . The contractor may then discontinue steaming and uncover the beam. Cure the test specimens used to determine the above strength as specified in [503.3.2.3](#).
- (6) If steam-curing girders, release the prestressing strands immediately after steam curing. Cut or release strands in a sequence that produces a minimum amount of eccentricity of prestress force in the beam.
- (7) If the contractor wants to remove the forms before completing the steaming, the contractor may uncover the beam one side at a time and for as much length as required to remove the form sections. Immediately replace the covering after removing each form section. During this operation, the contractor shall not expose the forms and beam surface for more than 30 minutes.

503.3.2.3 Test Cylinders for Release of Pretensioned Steel

- (1) Make test cylinders for determining the time for releasing the pretensioned steel. Make the test cylinders 6 inches by 12 inches (150 mm by 300 mm) in size and mold them in suitable steel or plastic molds. Cure the test cylinders with the represented concrete member until removal for capping and testing. Ensure that at least 2 cylinders have strengths above the minimum specified required strength, or average above the specified minimum with the lower not more than 5 percent below this strength, before releasing the tension. Make these test cylinders in addition to the cylinders designated in [503.2.2](#) for determining the 28-day strength.

503.3.2.4 Surface Finish

- (1) Provide an ordinary surface finish on the exposed surfaces of prestressed concrete members as specified in [502.3.7.5](#) before shipping from the plant. Provide a wire brush or stiff broom finish on surfaces to be bonded.

- (2) The manufacturer of prestress concrete girders or other members shall notify the engineer of: all extensive honeycomb deep enough to expose the prestressing steel, defects that may affect bond length or transfer length, or any area that the manufacturer believes to be extensive or detrimental. The engineer responsible for inspection at the prestress concrete manufacturing plant will consult with the manufacturer to determine the corrective action required to repair the member. The prestress manufacturing plant is responsible for rejecting prestress members that cannot be effectively repaired. The engineer is responsible for final acceptance.
- (3) Provide a sack rubbed surface finish on the outer face of outside prestressed girders or other members before shipping from the plant, unless the special provisions specify otherwise. After the sack-rubbed finish adequately cures, apply engineer-approved concrete sealer for non-trafficked surfaces uniformly to all sack-rubbed surfaces using the manufacturer's recommended rate and procedures.

503.3.3 Transportation, Storage, and Erection

- (1) Transport, handle and store the prestressed girders in an upright position, and ensure that points of support, and direction of the reactions with respect to the girder are approximately the same during transportation, storage, and erection as when the girder is in its final position. The maximum overhang from the point of support to the end of girder during storage, handling, and transporting shall not exceed the depth of the girder unless the engineer allows a larger overhang.
- (2) Handle, store and erect all prestressed concrete units in a manner that prevents cracking or other damage to the unit. Discard and replace units damaged by improper handling or storing at no expense to the department.
- (3) Only after attaining a minimum 28-day compressive strength, determined from test cylinders made, cured, and tested as specified in [503.2.2](#), may the contractor transport prestressed concrete girders to the work and erect. The engineer may allow delivery and erection of girders before their acceptance, pending strength tests, if the contractor provides in writing that it accepts responsibility for their removal and replacement in the event of rejection due to deficient strength.
- (4) The contractor shall not place floors on girders until the specified tests made on representative test cylinders indicate they achieved their minimum 28-day strength.
- (5) If, during the prestressed girders erection, the contractor elects to use a crane on the girders before placing and curing the concrete slab for the span, then the contractor shall submit details of the proposed temporary flooring, the strutting between the girders, and information about the crane used to the engineer for prior approval.
- (6) If steel cross ties are required between box- or slab-type girders, place and tighten them to the previously erected girder as each successive girder is placed.
- (7) If required to fill longitudinal joints between box- or slab-type girders with grout, place the grout after completing erection and adjustment of the girders. Use grout conforming to the plans or use an engineer-approved premixed commercial grout.

503.4 Measurement

- (1) The department will measure the Prestressed Girder bid items by the linear foot acceptably completed.

503.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
503.0100 - 0199	Prestressed Girder (type) (inch)	LF
503.0200 - 0299	Prestressed Girder Box (type) (inch)	LF
503.0300 - 0399	Prestressed Girder Slab (type) (inch)	LF

- (2) Payment for the Prestressed Girder bid items is full compensation for providing girders, including all concrete, grout, mortar, reinforcement steel, tie bars, anchor plates, and other embedded metal; for casting and curing concrete; for jacking and prestressing; and for all handling, hauling and erecting.
- (3) The department will accept prestressed concrete members with 28-day concrete cylinder strengths below the required 28-day compressive strength, as specified in [503.2.2](#), based on a pay reduction, if the 28-day concrete cylinder strength provided is greater than the design strength of the individual member as determined by the engineer. The department will reduce payment for an accepted member with 28-day concrete cylinder strength less than the required 28-day compressive strength by the greater of \$500, or 20 percent of the contract unit price applied to the measured length of the member.

- (4) If the 28-day concrete cylinder strength for the prestressed concrete member falls below the design strength of the individual member as determined by the engineer, obtain cores from each member according to AASHTO T 24, test according to AASHTO T 22, and evaluate for strength comparison. Obtain the engineer's approval for the core sample locations. If the average of 3 core strengths per member satisfies the design strength, and if none of the core strengths are less than 10 percent below the design strength, the engineer will accept the member based on the pay reduction defined above for deficient 28-day concrete cylinder strengths. The contractor may perform coring and testing, or an independent testing agency that the engineer approves may perform coring and testing. The engineer will observe coring and testing done by the contractor. All costs associated with taking, analyzing and testing cores are the contractor's responsibility.

SECTION 504 CULVERTS, RETAINING WALLS AND ENDWALLS

504.1 Description

- (1) This section describes constructing culverts, retaining walls, and endwalls.
- (2) This section applies to all culverts, whether the department classifies them as culverts, or bridges as defined in [section 101](#).
- (3) This work does not include furnishing or installing pipe culverts.

504.2 Materials

- (1) Furnish materials conforming to the following:

Concrete	section 501
Steel reinforcement.....	section 505

504.3 Construction

504.3.1 Concrete Composition

- (1) Unless specified otherwise, conform to the requirements for grade A, A-FA, A-S, A-T, A-IS, or A-IP concrete as specified in [section 501](#). Where the contract specifies or the engineer allows, the contractor may use high early strength concrete.
- (2) Conform to coarse aggregate sizes specified in [501.2.5.4.4](#) and [501.3.2.2](#).

504.3.2 Placing Concrete

- (1) Before placing concrete give the engineer sufficient notice to allow inspection of the forms, reinforcement, and casting preparations.
- (2) For constructing concrete box culverts, unless specified otherwise, place the curtain walls, base slab, and the barrel sidewalls as a single unit to an approximate height of 6 inches (150 mm) and allow to set before constructing the remaining culvert. Construct the sidewalls and top slab of box culverts as a monolith, unless specified otherwise. Allow not less than one hour or more than 3 hours to elapse between placing the concrete in the sidewalls and that in the top slab.

504.3.3 Removing Falsework and Applying Load

- (1) Do not remove culvert falsework with a span of 4 feet (1.2 m) or less until 5 days after pouring, exclusive of days subject to temperatures below 40 F (5 C), except if using concrete grades A-FA, A-S, A-T, A-IS, or A-IP, and did not control field operations by cylinder tests, then increase the time to 12 days. If controlling field operations by cylinder tests, the engineer may approve falsework removal, if cylinder tests show a compressive strength not less than 2000 pounds per square inch (13 800 kPa). Determine cylinder strengths as specified under falsework in [502.3.4.2](#). If using high early strength concrete, the engineer may reduce the above 5-day period to 3 days.
- (2) Remove culvert falsework with a span of more than 4 feet (1.2 m) according to [502.3.4.2](#) for removing falsework for concrete bridges.
- (3) The Contractor may backfill culverts, retaining walls, and end walls that have attained the specified compressive strength or upon expiration of the minimum times as specified in [206.3.13](#). Do not apply additional loads on culverts until attaining a compressive strength of 3500 psi (20.7 MPa) or, absent compressive strength information, for at least 21 days.

504.3.4 Name Plates

- (1) Install on each culvert and retaining wall, a nameplate conforming to [506.2.4](#) at the location the plans show or as the engineer directs. Attach the nameplate as specified in [502.3.11](#). Furnishing and placing the nameplate is incidental to the work.

504.3.5 Curing

- (1) Cure concrete in culverts, retaining walls, and end walls by any of the methods specified for curing substructure units in [502.3.8](#).

504.4 Measurement

- (1) The department will measure the several bid items that constitute the completed and accepted structure according to the provisions of the contract for those bid items and in the units the contract specifies. All work included within the scope of this contract but not listed as bid items in the proposal is incidental to the work.

- (2) The department will measure the Concrete Masonry Culverts bid items by the cubic yard acceptably completed. The department will not measure work or material for forms, falsework, cofferdams, unless specified otherwise. The department will not measure pumping, bracing, or other incidentals necessary to complete the work.
- (3) The department will measure the Concrete Masonry Retaining Walls bid items by the cubic yard acceptably completed. The department will not measure work or material for forms, falsework, cofferdams, unless specified otherwise. The department will not measure pumping, bracing, or other incidentals necessary to complete the work.
- (4) The department will measure Concrete Masonry Endwalls by the cubic yard acceptably completed. The department will not measure excavation, reinforcement, work or material for forms, pumping, bracing or other incidentals necessary to complete the work.

504.5 Payment

504.5.1 General

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
504.0100	Concrete Masonry Culverts	CY
504.0200	Concrete Masonry Culverts HES	CY
504.0500	Concrete Masonry Retaining Walls	CY
504.0600	Concrete Masonry Retaining Walls HES	CY
504.0900	Concrete Masonry Endwalls	CY

- (2) Perform miscellaneous work the plans show, or the contract otherwise specifies but does not list as a bid item, as a part of and included in the contract price for other contract bid items.
- (3) Payment for the Concrete Masonry Culverts bid items is full compensation for all materials, forms, falsework, placing, finishing, curing, protecting, and heating.
- (4) Payment for the Concrete Masonry Retaining Walls bid items is full compensation for all materials, forms, falsework, placing, finishing, curing, protecting, and heating.
- (5) Payment for Concrete Masonry Endwalls is full compensation for all excavating; all materials, including reinforcement; forms; placing, including reinforcement; finishing, curing, protecting and heating.

SECTION 505 STEEL REINFORCEMENT

505.1 Description

- (1) This section describes furnishing and placing bar steel, high strength bar steel or coated high strength bar steel.

505.2 Materials

505.2.1 General

- (1) Use materials conforming to the requirements for the class of material named and specified below.
- (2) Unless the plans show otherwise or the special provisions specify otherwise, use the deformed type for all bar steel, all high strength bar steel, and all coated high strength bar steel reinforcement. If plain, round steel reinforcement is specified, conform to ASTM A 675, grade 80 (550).
- (3) Use fabrication tolerances for straight and bent bars specified in Subsection 4.3, Tolerances, of the American Concrete Institute Committee 315, in the American Concrete Institute Detailing Manual.
- (4) Unless the contract specifies otherwise, submit a manufacturer's certified report of test or analysis showing the reinforcement conforms to the specifications to the engineer before incorporating the reinforcement into the work.

505.2.2 Bar Steel Reinforcement

- (1) Conform to AASHTO M 31.

505.2.3 High Strength Bar Steel Reinforcement

- (1) Conform to AASHTO M 31, grade 60 (420).

505.2.4 Coated High Strength Bar Steel Reinforcement

505.2.4.1 General

- (1) Conform to [505.2.3](#) and the following coating requirements:
- (2) The coating applicator must have an epoxy coating plant certification by the Concrete Reinforcing Steel Institute.
- (3) Bend all bars that require bending before coating, unless the fabricator can bend the bar without damaging the coating.

505.2.4.2 Coating Material

- (1) Use a department-approved powdered epoxy resin for the coating material.
- (2) The epoxy resin manufacturer shall supply to the coating applicator, any information on the resin it considers essential to the resins proper use and performance as a coating. The resin manufacturer shall also furnish written certification that the material is the same formulation and quality as the material supplied for prequalification tests.
- (3) The epoxy resin manufacturer shall provide patching or repair material, compatible with the coating and inert in concrete. This material shall be suitable for repairing areas of the coating damaged during fabrication or handling in the field.

505.2.4.3 Surface Preparation

- (1) Ensure the bar surface is clean and free from rust, scale, oil, grease, and similar surface contamination, and slivers, scabs and other surface defects detrimental to proper coating.
- (2) Blast the surface to a near white No. 10 finish according to SSPC-SP 10. Provide an anchor pattern with blast profile maximum roughness depth readings within the range of 1.6 mils to 4.0 mils (0.04 mm to 0.10 mm). Determine the readings according to NACE RP-287, using replica tape.
- (3) Remove all traces of grit and dust from the blasting before coating.
- (4) Apply the coating to the cleaned surface as soon as possible after cleaning and before visible oxidation of the surface occurs. The contractor shall not wait to apply the coating more than 8 hours after cleaning, unless the engineer directs otherwise.

505.2.4.4 Coating Process

- (1) Apply the coating as an electrostatically charged dry powder sprayed onto the grounded steel bars using an electrostatic spray gun. The contractor may apply the powder to either a hot or a cold bar. Give the coated bar the thermal treatment the epoxy resin manufacturer recommends to provide a fully cured finished coating.
- (2) Cure, post-cure, or cure and post-cure the coating film to a fully cured condition. The coating applicator shall check a representative proportion of each production lot, using the method it finds most effective for measuring cure, to ensure the entire production lot of coating is fully cured.

505.2.4.5 Test Bar Conditioning

- (1) Condition all bars being tested for coating thickness, holidays (pinholes not visually discernible), coating adhesion, and abrasion resistance at a temperature range of 68 F to 86 F (20 C to 30 C). If disputed, conduct tests at 73 F +/- 4 F (23 +/- 2 C) and 50 +/- 5 percent relative humidity according to ASTM D 3451 Section 3.1.

505.2.4.6 Coating Thickness

- (1) Ensure the coating is smooth and uniform in thickness. After curing is complete, ensure at least 90 percent of all recorded thickness measurements of the coating are 7 mils +/- 2 mils (0.25 +/- 0.05 mm). Thickness measurements below 5 mils (0.125 mm) are cause for rejection. The upper thickness limit does not apply to repaired areas of damaged coating. Measure the film thickness on a representative number of bars from each production lot according to ASTM G 12 for measuring film thickness of pipeline coatings on steel.
- (2) Take an average of 3 individual readings on the body of a straight length of bar between 3 consecutive deformations to obtain a single recorded thickness measurement. Obtain a minimum of 5 recorded measurements, evenly spaced along 2 sides of the test bar for a minimum of 10 recorded measurements per bar.
- (3) The contractor may use pull off and fixed probe gauges. Do not use pencil-type pull off gauges that require the operator to observe the reading at the instant the magnet is pulled from the surface. Follow the thickness gauge manufacturer's recommendations for its calibration and use.

505.2.4.7 Coating Continuity

- (1) Check the coating on a representative number of bars selected from each production lot after cure for continuity of coating and ensure it is free from holes, voids, contamination, cracks, and damaged areas. Additionally, ensure that not more than an average of 2 holidays exist in any linear foot (300 mm) of coated bar. Base the average on the bar's full production length.
- (2) Use a 67-1/2 volt holiday detector at the manufacturer's plant to check the coating.

505.2.4.8 Coating Flexibility

- (1) Evaluate the coating flexibility based on a representative number of bars selected from each production lot. Evaluate coating adhesion according to paragraph 8.3.1 of AASHTO M 284M.

505.2.4.9 Abrasion Resistance

- (1) Determine the coating's resistance to abrasion on a representative number of bars selected from each production lot, according to ASTM D 4060 using CS-10 wheels and a 1000 gram load per wheel, and ensure that the weight loss does not exceed 100 megagrams per 1000 cycles.

505.2.4.10 Inspection

- (1) Furnish a certificate of compliance for the surface preparation, coating material, and process. The coating applicator shall retain test results and make them available for not less than 7 years.

505.2.4.11 Damage Repair and Rejection

- (1) The contractor shall not repair epoxy coated high strength bar steel reinforcement that does not conform to the requirements for coating thickness, continuity of coating, coating cure, or flexibility of coating. Replace or strip, reclean, and recoat the epoxy coating according to [505.2.4](#) epoxy coated high strength bar steel reinforcement with one or more of these defects.

- (2) If using coated high strength bar steel reinforcement in bridges, the department requires patching on all circumferential areas with damaged coating, on all sheared or cut ends, on end areas left bare during the coating process, and on any areas that the entire coating is removed.
- (3) If using coated high strength bar steel reinforcement in noncontiguous concrete pavement and in those miscellaneous concrete construction bid items in section 416, the department requires patching on all circumferential areas with damaged coating or removed coating. The department will not require patching on sawed ends, cut ends, coated damaged ends, or end areas left bare during the coating process.
- (4) Perform patching with the material specified in [505.2.4.2](#) and according to the manufacturer's instructions.
- (5) Complete required repairs before visible oxidation of the steel surface occurs.
- (6) The engineer will reject bars having total damage greater than 2 percent of the total circumferential area of the bar length. Consider the entire loss of the coating at the specific area on the bar as total damage.

505.2.5 Welded Steel Wire Fabric for Concrete Reinforcement

- (1) Use a fabric of the weight and design the plans show and conform to AASHTO M 55.

505.2.6 Dowel Bars and Tie Bars

505.2.6.1 General

- (1) Furnish coated bars conforming to AASHTO M 31 M, grade 300 or 400. For dowel bars and straight tie bars, there is no requirement for bend tests. Ensure that the bars are the diameter and length the plans show.
- (2) The contractor need not coat or patch sawed ends, sheared ends, cut ends, ends left bare during the coating process, or ends with damaged coating.
- (3) The contractor need not repair circumferential coating damage from shipping, handling, or installation, if the following conditions are met:
 - 1. The damaged area is 1/4 inch (6 mm) square or smaller.
 - 2. The total damaged area in any one-foot (300 mm) length does not exceed 2 percent of the circumferential area in that length.
- (4) Repair all areas of damaged circumferential coating larger than 1/4-inch (6 mm) square. Reject all bars with total damage greater than 2 percent of the bar's circumferential area.

505.2.6.2 Dowel Bars

- (1) Coat dowel bars with a thermosetting epoxy conforming to AASHTO M 254, type B. The Concrete Reinforcing Steel Institute must certify the coating applicator's plant. Ensure that the bars are straight, round, smooth, and free from burrs or other deformations detrimental to the free movement of the bar in the concrete.
- (2) Saw or shear dowel bars to the required length. The department will allow shearing only if no damage occurs to the coating and shearing distortions do not exceed the following:
 - 1. No distorted diameter is more than 0.04 inches (1 mm) greater than the true diameter.
 - 2. No distortion extends more than 0.40 inches (10 mm) from the sheared end.
- (3) Apply a surface treatment, or furnish manufacturer treated bars, capable of preventing bond between the epoxy-coated bars and the concrete. Apply field surface treatments when loading bars in the dowel bar magazine or after staking the dowel basket to the grade.

505.2.6.3 Tie Bars

- (1) Coat tie bars as specified in [505.2.4](#) for coated high-strength steel reinforcement. Ensure that the tie bars are the shape the plans show.
- (2) Repair, with compatible coating material, the bend location of field-straightened coated tie bars.

505.2.7 Continuous Concrete Pavement Reinforcement

- (1) Provide reinforcing steel containing a minimum of 0.25 percent copper and conforming to AASHTO M 31. Use grade 60 (420) for longitudinal bars and grade 40 or 60 (300 or 420) for transverse bars.
- (2) Coat all pavement reinforcement bars and metal bar chairs for continuous concrete pavement reinforcement as specified in [505.2.4](#), except as follows:

- (3) There is no requirement to coat or patch sawed ends, sheared ends, cut ends, ends left bare during the coating process, or coated damaged ends
- (4) The contractor does not have to repair coating damage caused during shipping, handling, or installation, if the damaged area is 1/4 inch by 1/4 inch (6 by 6 mm) or smaller, and the total damaged areas in each one foot (300 mm) length does not exceed 2 percent of the circumferential surface area in the length. Repair all damaged areas larger than 1/4 inch (6 mm) square and reject all bars with total damage greater than 2 percent of bar circumferential surface area. The total circumferential surface area of the bar covered by patching material shall not exceed 5 percent.

505.3 Construction

505.3.1 Storage and Protection

- (1) Store reinforcement above ground on platforms, skids, or other supports and protect from mechanical injury and deterioration from exposure. Use reinforcement plainly marked to facilitate inspection and checking. If placing in the work, ensure the reinforcement is free from detrimental dirt, dust, paint, oil, or other foreign material. The engineer will not reject reinforcement with rust, seams, surface irregularities, or mill scale if the weight, dimensions, cross-sectional areas, and tensile properties of a hand wire-brushed test specimen conform to AASHTO M 31.
- (2) Use padded or non-metallic slings and padded straps for handling coated bar steel reinforcement. Store reinforcement on wooden cribbing and do not drop or drag it.

505.3.2 Bending

- (1) Use bent bar reinforcement cold bent to the shapes the plans show, and unless the plans show otherwise or the engineer directs otherwise, conform to Recommended Hooks All Grades and Recommended Sizes for Stirrup and Tie Hooks, of the American Concrete Institute Committee 315. Ensure all bending dimensions are out-to-out of the bar.

505.3.3 Splicing

- (1) Furnish bar steel reinforcement in the full lengths the plans show. The contractor shall not splice bars, except if the plans show, without the engineer's written approval. The contractor shall stagger splices. If the engineer grants permission to splice bars at locations other than those the plans show, the contractor shall furnish additional material required for the lap at not expense to the department.
- (2) Ensure that lapped splices conform to plan requirements, are placed in contact with each other, and wired together to hold the bars in position for the full length of the splice.
- (3) The engineer will not allow splices at points that do not offer a minimum distance of 2 inches (50 mm) between the splice and the nearest adjacent bar, or the surface of the concrete.
- (4) The contractor may use engineer-approved mechanical threaded butt connectors instead of lapped splices.
- (5) The contractor may weld reinforcement, if the plans show or the engineer authorizes in writing. The welding shall conform to AWS D 1.4, Reinforcing Steel Structural Welding Code, modified as follows:
 - 1. Use welders and welding procedures certified to the requirements of AWS D 1.4 or engineer-approved equal to perform all welding. If welder or welding operator certification tests are required, a department-approved independent testing agency shall perform the testing. If the engineer has reason to question a welder or welding operator's ability, the engineer will require prequalification tests according to AWS D 1.4.
 - 2. Make all welded splices direct butt splices. The contractor may use mechanical butt splicing, by the thermit or pressure gas process, instead of welding for No. 10 to No. 18 (35M, 45M and 55M) reinforcement bars with a carbon equivalent above 0.75.
 - 3. Test 4 percent of the total number of splices per each bar size, but not less than 4 splices, by radiographic methods.
 - 4. For qualification specimens and production splices, perform radiographing normal to the length of the root of the weld. Determine the adequacy of the radiographic technique by placing a square carbon steel bar of suitable length next to the reinforcing bar and include both bars in the radiograph. Use a square bar of the nearest standard size, within 1/16 inch (2 mm), of the dimension that is 90 percent of the diameter of the reinforcing bar being inspected. Place a penetrometer on the square bar adjacent to the weld. The thickness of the square bar will determine the number of the penetrometer. Consider the radiography satisfactory if the penetrometer number and smallest hole are visible on the radiograph.

5. If using mechanical butt splicing instead of welding, use a standard, engineer-approved, exothermic process that introduces molten filler metal, contained by a high strength steel sleeve of larger inside diameter than the bars, into the ring shaped space between the bars and the sleeve, and also between the ends of the bars. After the filler metal cools and hardens, ensure the splice transfers the stresses specified below from one bar to the other by the mechanical strengths of the splice components. The splice shall not depend upon fusion of the filler metal with the bars. The contractor shall not heat the bars to their melting point during the splicing process. The temperature required to perform the splice shall not decrease the bars structural properties or its original hardness. Make splices using the manufacturer's standard jigs, clamps, ignition devices, and other required accessories. The engineer must approve this process. Except as specified otherwise, perform splicing according to the manufacturer's recommendations as the engineer approves. As a condition of approval, the contractor shall make 2 test splices, in the engineer's presence, of each of the bar sizes intended for splicing by this method. Certified welders are not required to perform mechanical splicing.
6. Tension test the test splices to destruction, the requirement is to attain the minimum specified tensile strength of the bar steel reinforcement being spliced.
7. Instead of radiographing 4 percent of the mechanical butt splices, the contractor shall make sample splices equivalent to 4 percent of the total number of splices per bar size and furnish to the engineer for testing. Make the sample splices at intervals as the engineer directs in the field directs.
8. Select shielded metal electrodes according to AASHTO/AWS D 1.5 and submit a test report meeting the requirements for electrode acceptance as specified in 4.5.5 of AASHTO/AWS D 1.5.
9. Overlap the sheets of welded steel wire fabric to maintain uniform strength, and securely fasten at the ends and edges. Ensure the edge lap is at least one mesh wide.

505.3.4 Placing and Fastening

- (1) Place steel reinforcement precisely in the position the plans show and hold firmly during the concrete placing and setting by using spacer strips, stays, recycled plastic chairs, metal chairs, or other engineer-approved devices or supports. If using recycled plastic chairs, use them only to support the bottom layer of steel reinforcement. Unless provided otherwise, use coated high strength bar steel reinforcement in the top layer of reinforcement in the concrete deck.
- (2) Make metal chairs from stainless steel, that is zinc coated or epoxy coated after fabrication, or from uncoated steel with engineer-approved plastic tipped legs, or with at least 1/2 inch (13 mm) of the bottom of the legs hot dip zinc coated or plastic-coated. Furnish epoxy coated metal chairs or recycled plastic chairs to support coated high strength bar steel reinforcement, subject to the plastic chair restriction stated above. The epoxy coating thickness shall conform to [505.2.4.6](#).
- (3) Use recycled plastic chairs manufactured from recycled plastic obtained from post consumer products. Ensure they are chemically inert in concrete and are molded in a shape that does not restrict concrete flow and consolidation around and under the chairs.
- (4) For recycled plastic chairs conform to the following requirements within a temperature range of 20 F to 150 F (-7 C to 66 C):

PROPERTY	VALUE	ASTM TEST
Minimum shear strength	5000 psi (3405 MPa)	D 732
Minimum compressive strength	10,000 psi (69.0 MPa)	D 695M
Maximum water absorption	0.1 percent	D 570

- (5) Support bar steel reinforcement in the concrete deck as follows:
 1. Support bottom transverse bars with continuous bar chairs spaced 4 foot (1200 mm) on centers or closer. Place one line of chairs near each edge of slab to support the ends of the bars.
 2. Support top longitudinal bars with continuous bar chairs spaced 4 foot (1200 mm) on centers or closer.
 3. Provide one row of continuous bar chairs for support under each row of transverse bar splices.
- (6) The contractor may use precast concrete bricks or other engineer-approved bricks or blocking in structures to support reinforcement in footings or slabs placed on grade; however, the bricks or blocking shall not contact the reinforcement over a distance greater than the depth of a standard concrete brick. Tie the upper layer of reinforcement for bridge decks securely to the girders or forms at a longitudinal spacing not greater than 8 feet (2.44 m). For decks of slab span bridges, the ties shall have a transverse spacing not to exceed 8 feet (2.44 m), and for decks over girders, secure the ties to or next to each longitudinal line of girders.
- (7) Tie the bars securely at all intersections except if spacing is less than one foot (300 mm) in each direction, if alternate intersections are tied. The contractor shall not use tack welding to tie steel. Before placing any concrete in a unit or section, obtain the engineer's approval of the reinforcement placing and securing in that unit or section.

- (8) Tie coated bars using a procedure, equipment, and materials that will not damage or cut the coating. Tie coated reinforcement with one of the following:
1. Ties made from an engineer-approved plastic or nonmetallic material.
 2. Stainless steel wire.
 3. Nylon, epoxy, or plastic-coated wire.

505.4 Measurement

- (1) The department will measure the Bar Steel Reinforcement bid items by the pound acceptably completed. The department will compute the bar weight from the nominal weights for corresponding sizes for deformed bars in AASHTO M 31M. The department will not measure the extra metal used if the contractor chooses to substitute bars larger than those specified, the extra metal necessary for splices the plans do not show, or the weight of any devices used to support or fasten the steel in its correct position.

505.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
505.0105	Bar Steel Reinforcement Bridges	LB
505.0110	Bar Steel Reinforcement Culverts	LB
505.0115	Bar Steel Reinforcement Retaining Walls	LB
505.0405	Bar Steel Reinforcement HS Bridges	LB
505.0410	Bar Steel Reinforcement HS Culverts	LB
505.0415	Bar Steel Reinforcement HS Retaining Walls	LB
505.0605	Bar Steel Reinforcement HS Coated Bridges	LB
505.0610	Bar Steel Reinforcement HS Coated Culverts	LB
505.0615	Bar Steel Reinforcement HS Coated Retaining Walls	LB

- (2) Payment is full compensation for providing, transporting, and placing all reinforcement including supports.
- (3) Payment for the Bar Steel Reinforcement HS Coated bid items also includes coating, including epoxy coated metal chair supports.

SECTION 506 STEEL BRIDGES

506.1 Description

- (1) This section describes fabricating, furnishing, casting, machining or preparing otherwise, delivering, and erecting all the steel and miscellaneous metals required for steel bridges, or metal parts of other bridges.

506.2 Materials

506.2.1 General

- (1) Furnish materials conforming to the specifications for the several parts of the completed structure.

506.2.2 Structural Steel

506.2.2.1 General

- (1) Furnish structural steel for highway bridges and other structural purposes conforming to the following:
- (2) Furnish structural steel for highway structures conforming to the ASTM specifications the plans show. For material that the plans do not indicate the ASTM specifications, furnish structural carbon steel conforming to ASTM A 709 grade 36 (250) as modified in [506.2.2.4](#).
- (3) If the contractor cannot obtain structural carbon steel bar conforming to ASTM A 709 grade 36 (250) for use in secondary members in structures in the quantity for the contract shows, then use one or more of the following alternates:
 1. ASTM A 675, grade 60 (415).
 2. ASTM A 663, grade 60 (415).

506.2.2.2 Structural Carbon Steel

- (1) Use structural carbon steel, 4 inches (100 mm) or less in thickness, conforming to ASTM A 709 grade 36 (250), as modified in [506.2.2.4](#). For structural carbon steel over 4 inches (100 mm) in thickness, conform to ASTM A 36.

506.2.2.3 High Strength Structural Steel

- (1) Use high strength structural steel conforming to ASTM, as modified in [506.2.2.4](#), as follows:
 - HSLA columbium-vanadium steels of structural quality:
 - 50 ksi (345 MPa) minimum yield point to 4 inches (100 mm) thickASTM A 709, grade 50 (345)
 - HSLA weathering steel:
 - 50 ksi (345 MPa) minimum yield point to 4 inches (100 mm) thick ASTM A 709, grade 50W (345W)
 - High-yield-strength quenched and tempered alloy steel plate:
 - MartensiticASTM A 709, grade 100 or 100W (690 or 690W)
 - Non-martensitic..... ASTM A 709, grade 70W (485W)

506.2.2.4 Charpy V-Notch Requirements

- (1) All girder flange plates, girder web plates, flange splice plates, hanger bars, links, rolled beams, flange cover plates, and plates and angles connecting floor beams to girders shall conform to the longitudinal Charpy V-Notch tests specified in ASTM A 709 for zone 2 toughness requirements.
- (2) Sample and test according to ASTM A 673. Use the (H) frequency of testing.

506.2.3 Miscellaneous Metals

506.2.3.1 Steel Castings

- (1) If using carbon steel castings for bridges and general use, conform to class 70, 90, 120 (485, 620, or 825) of AASHTO M 192 and the following:
 1. Furnish the specific class of steel castings the plans show or are specified in the contract.
 2. The plans will specify the nondestructive tests to perform and their extent.
 3. Use steel castings that are true to pattern in form and dimensions without sharp, unfilleted angles or corners, and free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting strength and value for the service intended.

4. If the engineer approves, the contractor may weld defects by an engineer-approved process that does not impair the strength. Remove the defects to solid metal by chipping, drilling, or other satisfactory methods and then weld. If possible, perform this welding before annealing the casting. If the engineer requires, re-anneal any casting welded after annealing.
5. If the engineer requires, the contractor shall test castings by radiography or ultrasonic testing to determine the presence cracks, flaws, or other defects.
6. Ensure that the metal thickness remaining after completing the machining is not less than the thickness the plans show.
7. Thread the ends of the tensile test specimens for at least 3/4 inch (19 mm) with 3/4-inch (19 mm) American N.C. threads.

506.2.3.2 Bronze Castings

- (1) If using bronze castings for bearings, trunnions, journals of bridges, and expansion plates, conform to ASTM B 22, alloy No. C91100.

506.2.3.3 Cold-Finished Carbon Steel Shafting

- (1) Use cold-finished carbon steel shafting conforming to AASHTO M 169, grades 1016 through 1030. If used for structural pins, then conform to ASTM A 434, grade BC, quenched and tempered.

506.2.3.4 Lubricated Bronze Plates

- (1) Fabricate lubricated bronze plates as the plans show and with materials conforming to ASTM B 100, copper alloy No. C51000 or to ASTM B 22, alloy No. C91100.
- (2) Provide to the engineer a certified report of test or analysis indicating the manufacturer's test results for the lubricated bronze plates on their chemical and physical properties, including the coefficient of friction of the material used.
- (3) Bore or cast the surface of the lubricated bronze plates in a geometric pattern of recesses. Fill the recesses with a lubricating compound consisting of graphite and metallic substances with a lubricating binder capable of withstanding the atmospheric elements. Hydraulically press the compound into the recesses to form dense, non-plastic lubricating inserts. Ensure the lubricated area is within a range of 25 to 33 percent, inclusive, of the bearing face with a coefficient of friction not greater than 0.1. Unless the plans show or the contract directs otherwise, only lubricate the top face of the bronze plate.

506.2.3.5 Steel Forgings

- (1) Use steel forgings for pins, rollers, trunnions, and other forged parts conforming to the requirements for class M quenched and tempered forgings of ASTM A 668. Thread the ends of the tensile test specimens for at least 3/4 inch (19 mm) with 3/4-inch (19 mm) American N.C. threads.

506.2.3.6 Welded and Seamless Steel Pipe

- (1) Furnish welded and seamless steel pipe for railings and general use conforming to ASTM A 53, type F, or type E, grade B or type S, grade B. Unless provided otherwise, use black, standard weight pipe.

506.2.3.7 Pipe Fittings

- (1) Use malleable cast iron or pressed steel pipe fittings for railings and other required uses. If zinc coated fittings are required, the coating shall conform to ASTM A 123.

506.2.3.8 Sheet Lead

- (1) Furnish lead in sheet form conforming to ASTM B 29.
- (2) Use lead sheets of uniform thickness throughout, free from cracks, seams, slivers, scale, and other surface defects.
- (3) Unless the plans show otherwise, use sheet lead 1/8 inch (3 mm) in thickness with a tolerance of +/- 1/32 inch (0.8 mm). Ensure that the length and width are within 1/8 inch (3 mm) of the plan dimensions.

506.2.3.9 Sheet Copper

- (1) Furnish strip or sheet copper conforming to ASTM B 152 and suitable for the purpose intended. Unless specified otherwise, use sheet copper with a minimum thickness of 0.02 inch (0.5 mm).

506.2.3.10 Sheet Zinc

- (1) For sheet or plate zinc, conform to Prime Western Grade ASTM B 6.

- (2) Use sheet and plate zinc of uniform thickness, free from cracks, seams, slivers, scale, surface corrosion, adhering matter, and other surface defects.
- (3) Use sheet and plate zinc of the zinc gauge the plans show, with a thickness tolerance of +/- 6 percent. Use sheets that are within 1/8 inch (3 mm) of the length and width the plans show.

506.2.3.11 Welding Materials

- (1) Conform to AASHTO/AWS D 1.5, Bridge Welding Code.

506.2.4 Name Plates

506.2.4.1 General

- (1) For nameplates installed on bridges and culverts conform to the following requirements.

506.2.4.2 Composition

- (1) Provide nameplates made of metal with the following composition by weight:

Copper.....	84 to 96 percent
Lead.....	4 to 6 percent
Zinc.....	4 to 6 percent
Tin.....	4 to 6 percent
Impurities	Not over 1 percent
- (2) Make chemical determinations according to pertinent ASTM standard procedures.

506.2.4.3 Casting

- (1) Provide a nameplate cast to conform to dimensions and details the plans show.
- (2) Raise the border boss, the boss for anchors and lugs, and raise all lettering and numerals 1/8 inch (3 mm) above the plate face. If attaching the plate by bolts, cast the boss for anchor bolts solid and then drill, but if attaching the plate by lugs, cast the boss and then leave undrilled. Polish the top surface of the border boss, the boss for anchors and lugs, and all lettering and numerals. Make all letters Gothic or block and make square cut on top with sufficient taper to provide the necessary draft to allow removing the mold.
- (3) If attaching the plate to metal, attach it to the structure by 2 bolts. Use 1/4-inch (M6) bolts with countersunk metal heads made with the composition specified above for nameplates.
- (4) If attaching the plate to concrete, attach it to the structure by 2 lugs at least 3 inches (75 mm) long and cast integral with the nameplate.

506.2.5 High Strength Bolts

506.2.5.1 General

- (1) If using high strength bolts in fabricating structural steel rigid joints, conform to AASHTO M 164, unless specified otherwise, and supplement with the following provisions.
- (2) The hardness for M12 to M24 bolts inclusive shall conform to the following:

BOLT SIZE	HARDNESS NUMBER	
	BRINELL	ROCKWELL C
	minimum / maximum	minimum / maximum
1/2 to 1 inch (M12 to M24)	248 / 311	24 / 33

- (3) If using high-strength bolts, nuts, and washers to fabricate the rigid joints of unpainted, high-strength, low-alloy structural steel conforming to ASTM A 709, grade 50 (345), use type 3, unless specified otherwise.
- (4) For all other high strength bolts, nuts, and washers not encased in concrete, conform to the requirements for Type 1 and ensure they are hot dip zinc coated.
- (5) Washers shall conform to AASHTO M 293.
- (6) Nuts shall conform to AASHTO M 291 or M 292, as applicable.
- (7) Perform hot-dip zinc coating according to ASTM A 153. Instead of hot-dip zinc coating, the contractor may mechanically zinc coat bolts, nuts, and washers according to ASTM B 695, class 50. Remove excess hot-dip zinc coating on threaded portions by centrifuging or air blasting immediately after withdrawal. The contractor shall not perform flame-chasing.

- (8) If hot-dip zinc coating or mechanically zinc coating nuts, use heat-treated ASTM A 194 grade 2H or ASTM A 563 grade DH or DH3.
- (9) Use zinc coated nuts that are tapped oversize according to ASTM A 563 and conforming to supplementary requirement S1 of ASTM A 563. Over tap the nut so that the nut assembles freely on the bolt in the coated condition and conforms to the mechanical requirements of AASHTO M 291 and the rotational-capacity test specified in [506.2.5.6](#).
- (10) During field installation, lubricate zinc coated nuts with a lubricant containing dye that contrasts with the color of the zinc coating.
- (11) For plain, uncoated nuts use grade 2, C, D or C3 with a minimum Rockwell hardness of 89 HRB or minimum Brinell hardness of 180 HB, or use heat treated grade 2H, DH or DH3.

506.2.5.2 Bolt and Nut Dimensions

- (1) Use high strength bolts and nuts conforming to the dimensions the plans show and as specified in AASHTO M 164. Determine the length as specified in [506.2.5.4](#).

506.2.5.3 Washer Dimensions

- (1) Use circular washers that are flat, smooth, and hardened, and conform to the dimensions specified in AASHTO M 164.
- (2) Install bolts with a washer under the nut or bolt head, whichever is used in tightening. If the bearing faces of the bolted parts have a slope of more than 1:20 with respect to a plane normal to the bolt axis, use smooth, hardened, and beveled washers to compensate for lack of parallelism.
- (3) If clearance is necessary, the contractor may clip washers on one side to a point not closer than 7/8 of the bolt diameter from center of washer.

506.2.5.4 Bolt Lengths

- (1) The required bolt length is the grip, total thickness of the connected material, plus the tabulated amount for each bolt size as follows:

BOLT SIZE	AMOUNT ADDED TO THE GRIP
5/8-inch (M16)	1 1/16 inch (27 mm)
3/4-inch (M20)	1 3/16 inch (31 mm)
7/8-inch (M22)	1 5/16 inch (34 mm)
1-inch (M24)	1 9/16 inch (40 mm)
1 1/8 to 1 1/4-inch (M30).....	1 13/16 inch (46 mm)
1 3/8 to 1 1/2-inch (M36).....	2 1/16 inch (53 mm)

- (2) The above values are generalized, with allowance for manufacturing tolerances, to provide for a washer and using a heavy nut, with adequate stick-through at the end of the bolt. For each required beveled washer, add 5/16 inch (8 mm); for any additional washer, add 3/16 inch (5 mm); and for a load-indicating washer, add 1/8 inch (3 mm). Adjust the length determined from the above table increment and allowances for additional washers to the next 1/4 inch (6 mm) length increment for bolts up to 5 inches (125 mm) length and to the next 1/2 inch (13 mm) length increment for lengths over 5 inches (125 mm).
- (3) For bolt lengths determined as provided above, the full thread may extend into the grip not more than 3/8 inch (10 mm) for lengths of 5 inches (125 mm) or less, and not more than 5/8 inch (16 mm) for lengths over 5 inches (125 mm).

506.2.5.5 Identification

- (1) For high strength bolts, nuts, and washers, provide identification marks specified in ASTM A 325 for the type furnished.

506.2.5.6 Testing and Reporting

- (1) Test according to AASHTO M 164, M 291M, M 292 or M 293, as applicable, except that for rotational capacity testing conform to FHWA supplemental contract specifications for projects with AASHTO M 164 (ASTM 325) high strength bolts.
- (2) The contractor shall furnish 2 copies of a certified report of test or analysis indicating the results of required tests.

506.2.6 Bearing Pads

506.2.6.1 General

- (1) For bearing pads intended for bridge seats use sheet lead or preformed fabric pads or, if designated, elastomeric bearing pads.
- (2) Furnish bearing pads conforming to the plan details.
- (3) Under the Bearing Pads bid items, if the specific type of bearing pad is not designated, the contractor may furnish either sheet lead or class A preformed fabric pads. Use only one type of bearing pad throughout any one structure unless the plans or the contract provide otherwise.

506.2.6.2 Sheet Lead

- (1) Use sheet lead for bearing pads conforming to [506.2.3.8](#).

506.2.6.3 Preformed Fabric, Class A

- (1) This material consists of preformed fabric pads composed of multiple layers of 8-ounce (227 g) cotton duck impregnated and bound with high-quality natural rubber, or of equivalent and equally suitable materials compressed into resilient pads of uniform thickness. The number of plies shall produce the specified thickness after compression and vulcanizing. The finished pads shall withstand compression loads perpendicular to the plane of the laminations of not less than 10,000 pounds per square inch (69 MPa) without harmful extrusion or reduced thickness, under tests conducted according to MIL-C-882E procedures.

506.2.6.4 Non-Laminated Elastomeric

- (1) For non-laminated elastomeric bearing pads, use preformed pads, formed by casting or extruding natural rubber or chloroprene under pressure and heat. Cast or extrude the pads in a single, integral layer to the required thickness.
- (2) The pads shall conform to the following physical properties:

	NATURAL RUBBER	CHLOROPRENE
Grade (durometer)	60	60
Physical properties		
Hardness (ASTM D 2240)	60±5	60±5
Tensile strength (ASTM D 412).....	2500 psi (15.5 MPa)	2500 psi (15.5 MPa)
Ultimate elongation, minimum percent.....	400	350
Heat resistance, 70 hrs. at 158 F (70 C) (ASTM D 573)		
Hardness, maximum points change	+10	+15
Tensile strength, maximum percent change	-25	-15
Ultimate elongation, maximum percent change	-25	-40
Compression set (ASTM D 395, method B)		
22 hrs. at 158 F (70 C) maximum percent	25	N.A.
22 hrs. at 212 F (100 C) maximum percent	N.A.	35
Ozone (ASTM D 1149), 20 percent strain, 100 ± 2 F (38 ± 1 C)		
mounting procedure ASTM D 518, method A		
25 pphm ozone in air by volume, 48 hrs.	No cracks	N.A.
100 pphm ozone in air by volume, 100 hrs.	N.A.	No cracks

- (3) Evaluate the material furnished for acceptance based on the manufacturer's certified report of test or analysis indicating it conforms to these special properties, but the department may obtain test specimens. Before using the material, furnish to the engineer a manufacturer's certified report of test or analysis.
- (4) For test specimens, if required, conform to ASTM D 3184 or D 3190, as applicable.

506.2.6.5 Laminated Elastomeric

506.2.6.5.1 General

- (1) Use laminated elastomeric bearing pads conforming to [506.2.6.4](#) and the requirements below.

506.2.6.5.2 Pad Construction

- (1) Mold together all components of a laminated bearing into an integral unit and cover all the laminate edges with a minimum of 1/4 inch (6 mm) of elastomer, except at laminate restraining devices and around holes that will be closed on the finished structure.
- (2) The contractor may cut all elastomer pads from large sheets of the material cast to the required thickness. Cut the pads in a manner that avoids heating or damaging any material. Produce edges at least as smooth as an ANSI 250 finish (steel mill finish).
- (3) Cover the metal reinforcement edges with 1/4 inch (6 mm) of elastomer. Dimension tolerances and configurations shall conform to Division II Section 25.5 of the AASHTO Standard Specifications for Highway Bridges, except for the thickness of the elastomer cover over top and bottom steel plates use a tolerance of +/- 1/16 inch (2 mm).
- (4) For the internal steel plates use rolled mild steel conforming to ASTM A 36, or ASTM A 570 Grade 36 (250) or higher.
- (5) Submit shop drawings conforming to [506.3.2](#).
- (6) Mold the manufacturer's name or trademark into the edge of each laminated bearing pad on a face visible after structure erection.

506.2.6.5.3 Testing

- (1) Perform adhesion testing by slitting, on the top or bottom of the bearing pad, approximately a one-inch (25 mm) wide by 4 inch (100 mm) long strip of elastomer. Make the slits the depth of the steel plate. Peel back the strip of elastomer far enough to form a tab that can be gripped with grips approximately one inch (25 mm) from the elastomer-steel interface. Grip the elastomer tab with jaws attached to a load cell and pull at an angle of 90 +/- 2 degree to the steel plate. Measure the adhesion value as the force required to initiate peeling of the elastomer from the steel plate.
- (2) The pads shall conform to the following physical properties:

	NATURAL RUBBER	CHLOROPRENE
ADHESION TEST:		
Bond made during vulcanization, ASTM D 429, method B	40 psi (18 kg/25 mm)	40 psi (18 kg/25 mm)
LOW TEMPERATURE TEST:		
Brittleness at -40 F (-40 C), ASTM D746, procedure B	No failure	No failure

- (3) The manufacturer shall select a minimum of one bearing pad for each size category of a production run at random for load testing. Load test a minimum of one bearing pad for every 50 bearing pads of a single production run for the project. The manufacturer shall provide bearing pad test data and certification to the contractor at least 30 days before shipping. The manufacturer shall label all test bearing pads and ship to the contractor.
- (4) The compressive strain in any layer of an elastomeric bearing pad shall not exceed 7 percent at 800 pounds per square inch (5500 kPa) average unit pressure at 70 F (21 C) under laboratory testing for the full size bearing pad.
- (5) Use a compressive load of 1200 pounds per square inch (8300 kPa) for proof load testing. The engineer will reject the bearing pads if bulging patterns imply laminated placement does not satisfy design criteria and manufacturing tolerances, or if bulging suggests inadequate laminate bond. The engineer will also reject the bearing pads if there are 3 separate surface cracks greater than 1/16 inch (2 mm) wide by 1/16 inch (2 mm) deep.
- (6) The shear resistance of laminated bearing pads shall not exceed 40 pounds per square inch (275 kPa) for 60 durometer natural rubber or 75 pounds per square inch (517 kPa) for 55 durometer chloroprene compounds at 25 percent strain of the total effective rubber thickness after an extended 4 day ambient temperature of -20 F (-29 C).
- (7) The contractor shall assume the cost for bearing pad testing.

506.2.7 Welded Stud Shear Connectors

- (1) For shear connector studs conform to ASTM A 108, cold-finished bars, grades 1015, 1018, or 1020, either semi- or fully killed. If using flux-retaining caps, use low carbon grade steel for the caps suitable for welding that comply with ASTM A 109.
- (2) Tensile properties, determined testing bar stock after drawing, or of finished studs, shall conform to the following:

Minimum tensile strength.....	60 ksi (413.7 MPa)
Minimum yield strength ^[1]	50 ksi (344.7 MPa)
Minimum elongation.....	20 percent in 2 inches (50 mm)
Minimum reduction of area	50 percent
- ^[1] As determined by the 0.2 percent offset method.
- (3) Determine tensile properties according to ASTM A 370. Perform tensile tests of finished studs on studs welded to test plates using a test fixture similar to that shown in figure 7.2 of AASHTO/AWS D 1.5. If fracture occurs outside the middle half of the gauge length, repeat the test.
- (4) Ensure that finished studs are of uniform quality and condition, free from injurious laps, fins, seams, cracks, twists, bends, or other injurious defects. Produce the finish by cold drawing, cold rolling, or machining.
- (5) The contractor shall not paint or zinc coat studs.
- (6) Furnish arc shield (ferrule) of heat-resistant ceramic or other material with each stud that does not damage the welds, or does not cause excessive slag, and will not crumble or break due to thermal or structural shock before completing the weld.
- (7) The contractor shall submit the following information on the studs to the engineer for approval before installation:
 - The name of the manufacturer.
 - A detailed description of the stud and arc shield.
 - Documentation that the studs qualify as specified in ANSI/AASHTO/AWS D 1.5.

506.2.8 Bearing Assemblies

506.2.8.1 General

- (1) Use bearing assemblies conforming to the material requirements, sizes, and details the plans show.
- (2) Blast clean fabricated structural steel bearing components as specified in [506.3.31.3](#) before zinc coating. After zinc coating, apply a wash primer to the components and the coating system in the color selected for the structural steel under the concrete. If using weathering steel, paint the bearing assemblies with one coat of inorganic zinc-rich primer and one shop coat of high-build brown epoxy paint. The contractor shall not blast clean, zinc coat, or paint stainless steel and teflon surfaces.

506.2.8.2 Fixed Bearing Assemblies

- (1) Zinc coat the complete bearing assembly, including anchor bolts, nuts and washers, but excluding elements welded to the girder. Zinc coat the anchor bolts, nuts, and washers, according to ASTM A 153, class C. Zinc coat the remainder of the assembly according to ASTM A 123.

506.2.8.3 Expansion Bearing Assemblies

- (1) An expansion bearing assembly unit consists of a top sole plate, a bottom masonry plate, a rocker plate, a slide plate, side retainers, anchor bolts with nuts and washers, and a lead plate, all as described below and as the plans show.
- (2) Zinc coat all structural steel surfaces, including anchor bolts, nuts and washers, that do not come in contact with other structural steel surfaces, or stainless steel, or tetrafluoroethylene (TFE) surfaces, as specified in [506.2.8.2](#) for fixed bearing assemblies.
- (3) For the stainless steel sheet for the top element of sliding bearings use type 304 conforming to ASTM A 240 and ensure it is not less than 1/16 inch (1.6 mm) thick after finishing. Make the finished stainless surface a plane within a tolerance of 1/32 inch (0.8 mm) and with a 2B finish as specified in ASTM A 480.
- (4) During welding, protect the surface of the stainless steel plate from weld splatter.

- (5) After fabrication, provide a near mirror finish on the surface of the stainless steel plate.
- (6) Use TFE materials that are virgin tetrafluoroethylene fluorocarbon resin, unfilled. The finished materials shall exhibit the following physical properties:

REQUIREMENT	TEST METHOD	UNFILLED VALUE
Hardness at 78 F (26 C)	ASTM D 2240 Shore "D"	50-65
Tensile strength, psi (kPa)	ASTM D 1457	2800 (19 300) Min.
Elongation, percent	ASTM D 1457	200 Min.
Deformation under load		
% at 73.4 F (23 C) & 2000 psi (13 800 kPa)	ASTM D 621 method A	15 Max
Specific gravity	ASTM D 1457	2.14 Min.
Melting point	-	623 +/- 2 F (328 C +/-1)

- (7) Ensure the finished TFE sheet is not less than 1/16 inch (1.6 mm) or more than 3/32 inch (2.4 mm) thick.
- (8) Bond the TFE sheet to the 1/2 inch (13 mm) steel sheet with extreme care using a proven high-temperature-resistant epoxy bonding material. Use a 2-component, medium viscosity epoxy resin conforming to ASTM D 1763 for this purpose.
- (9) The engineer may allow welding to steel plate that has a bonded TFE surface provided welding procedures are established that restrict the maximum temperature reached by the bond area to less than 300 F (149 C), use temperature indicating wax pencils or other suitable means to determine temperature.
- (10) If epoxy bonding TFE sheets, ensure that one side of the TFE sheet is factory treated by the sodium naphthalene or sodium ammonia process by a department-approved manufacturer.
- (11) Perform TFE bonding at the bearing manufacturer's factory under controlled conditions and according to the engineer-approved adhesive systems manufacturer's written instructions. The bonding operation should produce a TFE surface that is smooth and free from bubbles.
- (12) At installation, ensure the stainless steel sliding face of the upper element and the TFE sliding face of the lower element have the surface finish specified and are clean and free of all dust, dirt, moisture, or any other foreign matter.

506.2.9 Steel Diaphragms

- (1) Furnish steel diaphragms conforming to the plan details.

506.2.10 Zinc Coated Fabrication

- (1) Conform to ASTM 385 for fabricating zinc coated work.

506.2.11 Accepting Secondary Fabrication Items by Certification

- (1) Contractors shall obtain all bridge metal secondary fabrication items from fabricators whose products conform to the department's certification method of acceptance for bridge metal secondary items, unless the engineer agrees to accept these items according to the alternate procedures set forth in the department's certification acceptance procedures. Secondary fabrication items are defined as:

Rail posts	Expansion devices
Anchor assemblies for rail posts	Curb and sidewalk cover
Plates	Floor drains
Sleeves	Guard rail anchors
Shims	Sheet lead
Rail panels	Elastomeric pads
Anchor bolts	Bearing assemblies (steel)
Protection angles	Structural steel diaphragms
Structural fasteners	

506.3 Construction

506.3.1 General

- (1) This work includes everything reasonably considered necessary for a complete and finished job according to the plans and contract.

- (2) Provide a quality and finish equal to the best general practice in modern bridge shops. Neatly finish all portions of the work exposed to view. Perform shearing, flame cutting, and chipping, carefully and accurately. For members requiring Charpy V-Notch testing, the contractor shall not cut by shearing or full-size hole punching.

506.3.2 Shop Drawings

- (1) Shop drawings shall conform to the contract plans and consist of shop detail, erection and other working plans or computations showing dimensions, sizes of material, including the dimensional properties of all rolled shapes, details and other information necessary for completely fabricating and erecting metal work. Each sheet of the shop drawings shall carry the project and the structure numbers.
- (2) The contractor shall submit to the engineer, for placing on file before commencing fabrication, one set of shop drawings that the contractor has checked. In addition, provide 2 sets to the district office and one set to the bureau of structures for inspection purposes. Only then may fabrication commence without awaiting the results of any review the engineer may make. The engineer may refuse prints of shop drawings that are not clear and legible. If the engineer requests, submit one additional copy of drawings for review. After review, the contractor shall furnish as many copies of shop drawings as required.
- (3) The shop drawings become a part of the contract, provided any differences between sections on shop drawings and sections the plans show are made only if the engineer approves and if the substitution is made at no additional expense to the department.
- (4) After initial submittal and review, make no deviation from the shop drawings or changes to them without the engineer's further review.
- (5) The engineer's review of shop drawings means only a review of the character and sufficiency of the details and does not relieve the contractor from responsibility in regard to errors or omissions on those drawings.
- (6) The fabricator, upon completing contracts involving structures supporting railroads, shall deliver to the railroad company one set of shop drawings of the structures.

506.3.3 Structural Steel Identification

- (1) In addition to ordinary mill identification, paint the appropriate color, according to ASTM A 6, on all structural steel, except steel conforming to ASTM A 709, grade 36 (250) without toughness requirements, on each end of each piece before shipment from the mill. Before working any piece in the shop, move the identifying paint marks a sufficient distance away from the end to ensure the identity of the piece during fabrication. Mark angles on the inside of a leg. Mark beams and channels on the inside of a flange. Paint the ends of pieces if assembly will destroy or make identification by the above methods impossible. If the contractor fails to exercise the above precautions, the engineer will reject the piece.

506.3.4 Rolled Material

506.3.4.1 Straightening

- (1) Ensure rolled material is straight before being laid off or worked. If straightening is necessary, perform it without injuring the metal. The engineer may reject material with sharp kinks and bends.

506.3.4.2 Camber

- (1) If the plans show, camber all rolled beams. The camber shall conform to a uniform, approximately circular curve for the entire length of the beam or between designated points. Ensure the designated camber is within the tolerance specified in the American Institute of Steel Construction Manual. The steel manufacturer may produce camber, or produce or correct it by local heating. If the plans show camber less than the minimum camber likely to remain permanent as tabulated in the Manual of Steel Construction of the American Institute of Steel Construction, produce the camber by applying heat.
- (2) If cambering beams or correcting camber by local heating, take care not to overheat the metal. The contractor shall not heat the metal above 1200 F (649 C). Select the areas to heat so that no distortion other than the required camber occurs. Follow a procedure that prevents beam flange warpage.
- (3) Support the beam near its ends facing the side made concave upward. Apply propane, natural gas, or other engineer-approved gas flame to areas selected so that no distortion other than the required camber occurs. Apply heat by playing the flame over the section until the metal attains a maximum temperature of 1000 F to 1200 F (538 C to 649 C). Control the temperature by using temperature- indicating crayons, liquids, or bimetal thermometers. Notify the engineer before applying any heat.

- (4) Heat the areas in generally wedge- or triangular-shaped areas with an included angle between 10 and 20 degrees. Locate the vertex of the angle on the web midway between flanges. Slowly play the flame over the area heated, commencing at the vertex of the angle and finishing at the widest part of the heated wedge, extending across the flange width. Manipulate the torch, or torches, to rapidly bring the total area heated to the proper temperature at the same time.
- (5) Space the heated sections to produce uniform curvature. Heat no less than 3 sections, and it may require heating additional sections if the beam is unusually long or heavily cambered. Do not use water to cool the metal, or heat any area more than once. Air cool the heated metal slowly away from wind or drafts. The engineer may reject the beam if improper heating or cooling occurs that might affect the strength or ductility of the metal.

506.3.5 Bolt Holes

- (1) Punch or drill all holes for bolts. The contractor may punch bolt holes 1/16 inch (2 mm) larger than the nominal diameter of the bolts in material forming a member made of no more than 5 metal thicknesses and if the metal is not thicker than 3/4 inch (19 mm) for structural carbon steel, 5/8 inch (16 mm) for high strength structural steel, or 1/2 inch (13 mm) for quenched and tempered alloy steel. For more than 5 thicknesses, or if the main material is thicker than 3/4 inch (19 mm) for structural carbon steel, 5/8 inch (16 mm) for high strength structural steel, 1/2 inch (13 mm) for quenched and tempered alloy steel, or if required otherwise, subpunch, or subdrill all holes 3/16 inch (5 mm) smaller. After assembling, ream them 1/16 inch (2 mm) larger or drill from the solid to 1/16 inch (2 mm) larger than the nominal diameter of the bolts. The contractor may use oversized holes in secondary members if the engineer allows.
- (2) The die diameter shall not exceed the punch diameter by more than 1/16 inch (2 mm). If enlarging holes to admit the bolts, then ream the holes. Ensure clean-cut holes without torn or ragged edges. The engineer may reject poorly matched holes.
- (3) Make reamed or drilled holes cylindrical, perpendicular to the member and not more than 1/16 inch (2 mm) larger than the nominal diameter of the bolts. If possible, direct the reamers by mechanical means. Remove burrs on the outside surfaces. Poor matching of holes shall be cause for rejection. Perform reaming with tapered reamers. If removing burrs caused by drilling, take apart the assembled parts. For connecting parts that require reamed or drilled holes, assemble them first and then hold securely during reaming or drilling.

506.3.6 Accuracy of Holes

506.3.6.1 Punched and Drilled Holes

- (1) Ensure that all holes punched full size, subpunched, or subdrilled are so accurate that after assembling (before performing reaming) a cylindrical pin 1/8 inch (3 mm) smaller in diameter than that of the punched hole can enter it, without drifting, in at least 75 percent of the contiguous holes in the same plane. Failure to conform to this requirement will result in rejection of the badly punched pieces. In addition, the engineer will reject any hole that will not pass a pin 3/16 inch (5 mm) smaller in diameter than that of the punched hole.

506.3.6.2 Reamed and Drilled Holes

- (1) If holes are reamed or drilled, 85 percent of the holes in any contiguous group shall, after reaming or drilling, show no offset greater than 1/32 inch (1 mm) between adjacent thicknesses of metal.
- (2) Use steel templates that have hardened steel bushings in the holes, and are accurately dimensioned from the connection centerlines as inscribed on the template. Use the centerlines to accurately locate the template from the milled or scribed ends of the members.

506.3.7 Shop Assembly

506.3.7.1 General

- (1) Unless specified otherwise, subpunch or subdrill, and ream while shop assembled bolt holes in connections and splices (shop and field) of main truss or arch members, continuous beams, floor beam connections to girder or truss, continuous plate girders, and rigid frames; or drill them full size from the solid while assembled at the shop. Subpunch or subdrill floor beam connections for plate girders and trusses and ream or drill full size from the solid in assembly. The contractor may use engineer-approved alternate procedures.

- (2) Unless the engineer authorizes otherwise, assemble each individual truss, arch, continuous beam, or girder full length at the shop before reaming or drilling. Obtain approval of other than full-length assembly before submitting the shop drawings and show the engineer-approved alternate assembly procedure shall on the shop drawings. During shop assembly, support all members in a manner that does not cause undesirable deflections. The inspector will approve assembly, including camber, alignment, accuracy of holes, and milled joints, before drilling or reaming.
- (3) Conform to [506.3.27](#) for pickup points and girder handling equipment.
- (4) Ensure that the component parts of a built-up member are straight and close fitting. Matchmark all the members and all parts of the built-up members before disassembling.

506.3.7.2 Fitting for Bolting

- (1) Clean the metal surfaces in contact with other each other before assembling. Before drilling, reaming, or bolting, assemble the parts of a member, pin, and draw together. Take apart the assembled pieces in order to remove the burrs and shavings this operation produces. Ensure the member is free from twists, bends, and other deformation.
- (2) During assembly tolerate only the drifting necessary to bring the parts into position and not sufficient to enlarge the holes or distort the metal.

506.3.8 Flame Cutting

- (1) The contractor may flame cut structural steel, provided this process produces a smooth surface free from cracks and notches and a mechanical guide is used to produce an accurate profile. The engineer must approve hand cutting.
- (2) Flame cut plates in a direction that allows the stress in the plate, when assembled, to be parallel to the direction the plate was rolled.
- (3) Ensure that flame cutting is adjusted and manipulated to cut within the prescribed lines. Flame cut surfaces shall conform to the ANSI surface roughness value of 1000 for material up to 4 inches (100 mm) thick and 1600 for material 4 to 8 inches (100 to 200 mm) thick, except that the ends of members not subject to calculated stress at the ends shall have a surface roughness value of 2000. Round the corners of flame cut surfaces of members that carry calculated stress to approximately a 1/16-inch (2 mm) radius by grinding after flame cutting.
- (4) Cut re-entrant cuts to a radius of not less than one inch (25 mm).
- (5) Remove surface roughness exceeding the above values and occasional gouges not more than 3/16 inch (5 mm) deep on otherwise satisfactory flame cut surfaces by machining or grinding. Correct defects by flaring into the cut surface on a slope of at least 1 to 10. Repair gouges of flame cut edges more than 3/16 inch (5 mm) deep but not more than 7/16 inch (11 mm) deep by welding, if the engineer approves, with low-hydrogen electrodes not exceeding 5/32 inch (4 mm) in diameter and with a preheat of 250 F (121 C). Grind the completed weld smooth and flush with the adjacent surface.

506.3.9 Edge Planing

- (1) Plane the sheared edge of plates more than 5/8-inch (16 mm) thick and carrying calculated stress to a depth of 1/4 inch (6 mm).

506.3.10 Connections

- (1) Unless specified otherwise, make all connections with M 20 high strength bolts conforming to ASTM A 325.

506.3.11 (Vacant)

506.3.12 Bolts and Bolted Connections

506.3.12.1 General

- (1) Furnish sufficient bolts of each type, size, and length required with an ample surplus to replace those lost or rejected.
- (2) Perform shop assembly and matchmarking as specified in [506.3.7](#).
- (3) If assembled, ensure all joint surfaces, including those adjacent to washers, are free of scale, dirt, oil, burrs, pits, and other defects that prevent solid seating of the parts.

506.3.12.2 Unfinished Bolts

- (1) If using unfinished bolts for temporary connections and other specifically allowed uses, use standard bolts with hexagon heads and nuts. Ensure the bolt hole diameters are 1/16 mm (2 mm) greater than that of the bolt.
- (2) Thread bolts transmitting shear so that not more than one thread is within the grip of the metal. Use lock washers under the nuts for unfinished bolts used in permanent connections.

506.3.12.3 High Strength Bolts

- (1) Install bolts according to AASHTO Standard Specifications for Highway Bridges Division II, Article 11.5.6.4, with the following exceptions:
 1. If connections are assembled, install bolts with a hardened washer under the nut or bolt head, whichever is the element turned in tightening.
 2. If using oversized holes, 2 hardened washers are required, one under the bolt head and one under the nut.
 3. Bring the bolted parts into solid contact bearing before final tightening. Use not less than 25 percent of the total number of bolts in a joint to serve as fitting up bolts.
- (2) The contractor may use a flat washer if the surface adjacent to and abutting the bolt head or nut does not have a slope of more than 1:20 with respect to a plane normal to the bolt axis. For slopes greater than 1:20, use smooth, beveled washers to produce parallelism.
- (3) Tighten each fastener to provide, if all fasteners in the joint are tight, at least the minimum bolt tension as follows:

TABLE 506-1 BOLT TENSION

BOLT SIZE	REQUIRED MINIMUM BOLT TENSION ^[1]
1/2-inch.....	12 050 pounds
5/8-inch.....	19 200 pounds
3/4-inch.....	28 400 pounds
7/8-inch.....	39 250 pounds
1-inch.....	51 500 pounds
1 1/8-inch.....	56 450 pounds
1 1/4 inch.....	71 700 pounds
1 3/8-inch.....	84 450 pounds
1 1/2-inch.....	104 000 pounds

^[1] Equal to the proof load by the length measurement method as specified in ASTM 325 or ASTM 325M for metric bolts.

- (4) Tighten threaded bolts by the turn-of-nut method or by the load-indicator- washer method. If required, because of bolt entering and wrench operations clearances, the contractor may tighten by either procedure by turning the bolt while preventing the nut from rotating.
- (5) The contractor may propose an alternate tightening method but the engineer must approve it before use.
- (6) During installation, regardless of the tightening method used, exercise care to achieve the "snug tight" condition defined in AASHTO Standard Specifications for Highway Bridges Division II, Article 11.5.6.4.4.
- (7) Do not reuse zinc coated M 164 bolts. The contractor may reuse other M 164 bolts, if the engineer approves, but not more than once. The department will not consider re-tightening previously tightened bolts that become loosened by the tightening of adjacent bolts as reuse.
- (8) Perform the rotational-capacity test on each rotational-capacity lot before beginning bolt installation. Hardened steel washers are required as part of the test although the actual installation procedures may not require them.
- (9) Provide and use a Skidmore-Wilhelm Calibrator or an acceptable equivalent tension measuring device at each job site during erection. The contractor may test bolts that are too short for the Skidmore-Wilhelm Calibrator by using direct tension indicators calibrated in the Skidmore-Wilhelm Calibrator using longer bolts. Provide the engineer with 2 copies of the test results.
- (10) Install bolt, nut, and washer (if required) combinations from the same rotational-capacity lot.

- (11) Check zinc coated nuts to verify that a visible lubricant is on the threads.
- (12) Ensure that plain, uncoated bolts are oily to the touch over their entire surface when delivered and installed.
- (13) Clean and re-lubricate weathered or rusted bolts or nuts not conforming to the requirements above before installation. Retest all re-cleaned or re-lubricated bolt, nut, and washer assemblies before installation.

506.3.12.3.1 Turn-of-Nut Method

- (1) If using the turn-of-nut method to provide the bolt tension specified in table 506-1, first ensure that enough bolts are "snug tight" to insure the parts are in full contact with each other. Snug tight is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a person using an ordinary spud wrench. Following this operation, place bolts in any remaining holes in the connection and bring them to snug tightness. Then tighten all bolts in the joint by the amount of nut rotation specified in table 506-2 proceed tightening from the most rigid part of the joint to its free edges. During this operation, ensure the part not turned by the wrench does not rotate.

TABLE 506-2-NUT ROTATION FROM SNUG TIGHT CONDITION^[1]

	DISPOSITION OF OUTER FACES OF BOLTED PARTS		
Bolt length measured from underside of head to extreme end of point	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 washers 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]	2/3 turn	5/6 turn	1 turn

^[1] Nut rotation is relative to bolt regardless of the element, nut or bolt, being turned. For bolts installed by 1/2 turn and less, the tolerance should be +/- 30 degrees; for bolts installed by 2/3 turn and more, the tolerance should be +/- 45 degrees.

^[2] No research work has been performed by the Research Council on Riveted and Bolted Structural Joints to establish the turn-of-nut procedure when bolt lengths exceed 12 diameters. Therefore, determine the required rotation by actual tests in a suitable tension device simulating the actual conditions.

506.3.12.3.2 Load-Indicator-Washer Method

- (1) If using the load- indicator-washer method to provide the bolt tension specified in [506.3.12.3\(3\)](#), place an engineer-approved load indicator washer on the bolt with the protrusions facing away from the connected materials. Place a hardened washer under the element, nut or bolt head, turned in tightening. If required to use the tension indicator under the turned element, fit the hardened washer against the protrusions of the load indicator washer.
- (2) Reduce the average gap between the face of the indicator and the underside, washer face of the bolt to the minimum gap specified by the manufacturer to produce the required bolt tension. If the indicator washer is in place under the turned element, reduce the average gap between the indicator and the hardened washer according to the manufacturer's recommendations to provide the correct tension. During the operation, ensure no rotation of the part not turned by the wrench.
- (3) Check the gaps on a minimum of 25 percent of the bolts with a metal feeler gauge and according to the gaps the manufacturer recommends for the tension required. Inspect the first bolts used to bring the joint in contact to ensure no loosening occurred during the complete tightening procedure. The contractor may restore the tension on these bolts by tightening to less than the original. If the gap between the indicator and washer or bolt head is completely closed on a bolt, discontinue tightening s to prevent breakage.

506.3.12.3.3 Inspection

506.3.12.3.3.1 General

- (1) Perform all specification requirements for bolt connections to the engineer's satisfaction.
- (2) The procedure for bolt installation shall meet the engineer's approval.
- (3) Use the following inspection unless a more extensive or different inspection procedure is specified.

506.3.12.3.3.2 Turn-of-Nut Method

- (1) Either the engineer or the contractor in the presence of the engineer, at the engineer's option, shall use a manual torque inspection wrench accurately calibrated as follows:
- (2) Place 3 bolts of the same grade, size, length, and condition as those being inspected, individually in a bolt tension calibration device (furnished by the contractor). Place a washer under the part turned in tightening each bolt. Tighten each bolt in the calibration device by any convenient means to the minimum tension specified for its size in [506.3.12.3](#). Then apply the inspecting wrench to the tightened bolt and determine the torque necessary to turn the nut or head 5 degrees, which is approximately one inch (25 mm) at a 12 inch (300 mm) radius, in the tightening direction. Use the average torque measured in the tests of 3 bolts as the job inspecting torque and use in the manner specified below.
- (3) Inspect the bolts represented by the sample described above that were tightened in the structure by applying, in the tightening direction, the inspecting wrench and its job inspecting torque to 10 percent of the bolts, but not less than 2 bolts, selected randomly in each connection. If this process does not turn any nut or bolt head then the engineer will accept the connection as properly tightened. If this process does turn any nut or bolt then apply this torque to all bolts in the connection, and re-tighten and re-inspect all bolts whose nut or head turns, or the fabricator or erector has the option of re-tightening all bolts in the connection and then resubmitting the connection for the specified inspection.

506.3.12.3.3.3 Load-Indicator-Washer Method

- (1) If using load-indicator-washers, the engineer will witness use of the metal feeler gauge during installation.
- (2) Inspect load-indicator-washers by using a metal feeler gauge instead of a calibrated inspecting wrench. After completing the bolted connection, the engineer will inspect by using a metal feeler gauge on a minimum of 10 percent of the bolts, but not less than 2 bolts, selected randomly in each connection. If all gaps inspected are within the allowable gaps, the engineer will accept the connection as properly tightened. If any gaps checked are in excess of the recommended gap, the fabricator or erector shall re-inspect and re-tighten, as required, each bolt in the assembly and resubmit the connection for inspection.

506.3.13 Abutting Joints

- (1) Mill or saw cut abutting joints in compression members of trusses and in columns to give a true and square cut.
- (2) Openings at abutting joints in tension members in continuous I-beams and plate girders shall not exceed 3/8 inch (10 mm).

506.3.14 Facing of Bearing Surfaces

- (1) Make the top and bottom surfaces of steel slabs and the base plate and cap plates of columns and pedestals straight, smooth, and free from warp and must bear evenly throughout.
- (2) If necessary, plane the bases of welded steel bearings after welding to secure an even bearing.
- (3) Plane the bases of cast steel bearings after annealing to secure an even bearing.
- (4) Ensure that the sole plates of beams and girders have full contact with the flanges, and that the bearing surface is smooth, true, and perpendicular to the web of the member. Ensure that curved sole plates make full line bearing with masonry or bearing plates, and that the line is at right angles to the axis of the member and perpendicular to the web of the member unless the plans show otherwise.
- (5) If planning the curved surfaces of expansion bearings, operate the tool so that the cut is in the expansion direction. If the cut of the tool is at right angles, make the finished surface the true arc of a circle, smooth and free from ridges.
- (6) Finish contact steel surfaces subject to sliding motion in the direction of motion as specified in ANSI No. 125.

- (7) Machine finish all surfaces that the plans show to receive a surface finish.
- (8) Polish finish the surfaces of bronze bearing plates intended for sliding contact.
- (9) If using lubricated bronze plates, cover the finished surface of the expansion plate assembly in contact with the lubricated bronze plate with a plastic or other engineer-approved coating after machining. Before erecting the girder, remove this coating and coat the surface with graphite.

506.3.15 Web and Flange Plates

- (1) At bolted splices, the clearance between the ends of the web and flange plates shall not exceed 3/8 inch (10 mm).
- (2) If the plans show camber for welded girders, produce the camber by machine flame cutting the web plate. Cut all cambers on a continuous smooth curve. If the engineer approves, correct moderate deviations from specified camber by a carefully supervised application of heat.
- (3) For welded girders, if detailed to a horizontal curve greater than 3 degrees, cut the flange plates to a continuous smooth curve by machine flame cutting. If the curve is 3 degrees or less, curve the girder by either heat curving methods that the engineer approves, unless the plans specify otherwise. The contractor may curve the girder by machine flame cutting.
- (4) Assemble the web and flange plates in the work so that the direction of stress in the plate, as assembled, is parallel with the direction that the plate was rolled.

506.3.16 Fit of Stiffeners

- (1) Ensure that the end stiffeners of girders and stiffeners intended as supports for concentrated loads bear fully on the flanges that they transmit load to or from which they receive load. Obtain full bearing by milling, or grinding, or in the case of weldable steel in compression areas, by welding as the plans show or as specified.
- (2) If the clearance between the end of the stiffener and the flange for stiffeners is not intended to support concentrated loads, then the gap shall not exceed 1/16 inch (2 mm) unless the plans show or the contract specifies otherwise.

506.3.17 Pin and Roller Details

506.3.17.1 Pins and Rollers

- (1) Turn pins and rollers to the dimensions the plans show and make them straight, smooth, and free from flaws.
- (2) Forge and anneal pins and rollers that are more than 9 inches (229 mm) in diameter. For pins and rollers 9 inches (229 mm) or less in diameter use either forged and annealed or cold-finished, carbon-steel shafting.
- (3) In pins larger than 9 inches (229 mm) in diameter, bore a hole, not less than 2 inches (50 mm) in diameter and full length along the axis after the forging cools below the critical range under conditions suitable to prevent injury by too rapid cooling and before annealing.
- (4) Use standard recessed pin nuts for nuts in connection with pins.

506.3.17.2 Pinholes

- (1) Bore pinholes true to the specified diameter, smooth, straight, at right angles with the axis of the member, and parallel with each other unless required otherwise. Produce the final surface s by using a finishing cut.
- (2) The pinhole diameter for pins without bushings shall not exceed the pin diameter by more than 1/50 inch (0.5 mm) for pins 5 inches (127 mm) or less in diameter, or 1/32 inch (0.8 mm) for larger pins. For pins with bushings, follow the manufacturer's recommendations for tolerances of pins and bushings.

506.3.17.3 Threads for Bolts and Pins

- (1) Threads for all bolts and pins for structural steel construction shall conform to the Unified Standard Series UNC-ANSI B1.1, Class 2A for external threads and Class 2B for internal threads, except that pin ends with a diameter of 1 3/8 inch (35 mm) or more shall have 6 threads per one inch (25 mm).

506.3.18 Finished Members

- (1) Make finished members true to line and ensure they are free from twists, bends, and open joints.

506.3.19 Welding

506.3.19.1 General

- (1) Welding of steel structures shall conform to these specifications and to ANSI/AASHTO/AWS D 1.5, Bridge Welding Code.
- (2) Furnish welders or welding operators certified to the requirements of ANSI/AASHTO/AWS D 1.5. If the engineer questions a welder or welding operator's ability, requalification tests are required under ANSI/AASHTO/AWS D 1.5, paragraphs 5.31 and 5.42. A department-approved independent testing agency will perform requalification testing.

506.3.19.2 Welding Procedures, Procedure Qualifications and Inspection

506.3.19.2.1 Procedures

- (1) Submit the proposed complete welding procedures to the engineer in triplicate for approval before fabricating the structural steel.
- (2) The welding procedures include, but are not limited to, the following items:
 1. General instructions for fit-up, techniques, and welding sequences.
 2. Types of steel, joint description, joint preparation, preheat or post-heat, and welding position.
 3. Current polarity, amperage, wire speed, voltage, and linear welding speed.
 4. Electrode size and type for manual welding.
 5. Electrode size and AWS classification for automatic and semi-automatic welding.
 6. Classification of flux; number of passes, any procedure change between passes in the same weld.
 7. Any other data necessary to fully describe the welding procedure.
- (3) Use engineer-approved submerged arc automatic welding processes for all primary shop welds. Use an automatic welding process that uses mechanically controlled wire or electrode feed, speed of travel, and guidance. Noncompliance with this requirement is cause to reject the welded material unless the engineer grants prior approval to weld the specified joints by other processes. Show the automatic welding process requirement for primary shop welds on the shop drawings for each joint. Primary shop welds are defined as flange and butt welded splices in I-beams, box members and plate girders; plate girder or box flange to web groove and fillet welds; and cover plate to flange fillet welds.
- (4) Do not use electroslog or electrogas weld.
- (5) Grind all flange butt welds. Grind web butt welds as follows: 1/6 of the web depth beginning at the point of maximum tension, 1/6 of the web depth beginning at the point of maximum compression and the entire outside surface of exterior girders. Grind all surfaces that require grinding before performing radiographic or ultrasonic inspection. Grind plates with a surface or surfaces in the same plane flush. Grind plates with surfaces not in the same plane smooth.
- (6) Ensure that weld metal for fillet and groove welds for exposed, bare, unpainted applications of ASTM A 709 grade 50 (345) steel possess similar atmospheric corrosion resistance and the same coloring characteristics as that of the base metal.

506.3.19.2.2 Procedure Qualifications

- (1) Procedure qualifications shall conform to Section 5 of ANSI/AASHTO/AWS D 1.5.
- (2) The contractor shall complete qualification tests of the welding procedures and obtain the engineer's acceptance of them before beginning steel fabrication. Submit any revisions in the welding procedure specifications to the engineer for approval and qualify them in the presence of the State's inspector to qualify for acceptance.
- (3) Before the starting qualifying welding procedures, the contractor and the State's inspector shall confer to ensure reaching an agreement regarding the procedure details, the welding sequence, the handling of materials to be inspected, the status of welders and welding inspectors qualifications, and the approval of electrodes, wire, flux, and other welding materials and equipment.
- (4) Assign each welder or welding operator an identification mark for them to paint on the pieces welded. The welder or welding operator shall use these identification marks for the duration of the contract.

506.3.19.2.3 Inspection

- (1) Inspect welding according to ANSI/AASHTO/AWS D 1.5. Unless specified otherwise, test butt welds in main members by either the radiographic or the ultrasonic method.
- (2) Test fillet welds and groove welds not covered otherwise in main members in a non-destructive manner by the magnetic particle method according to ASTM E 709, utilizing the yoke method. This includes, but is not limited to, a minimum of 12 inches (300 mm) in every 10 feet (3 m) or portion thereof of each weld connecting web to flange, bearing stiffener to web or flange, framing connection bar to web or flange, and longitudinal stiffener to web or vertical bar.

506.3.20 Stud Shear Connectors

- (1) Use studs for shear connectors if the plans show. Weld according to [506.3.19](#) and the following requirements. If conflicts occur, the following requirements shall govern:
- (2) Fillet welds varying in size from 3/16 inch to 5/16 inch (5 mm to 8 mm) are satisfactory provided the studs pass all other required tests. Make adequate provision in structural member fabrication to compensate for camber loss due to shear connector welding.
- (3) Ensure the studs are free from rust, scale, rust pits, and oil at the time of welding and immediately before placing the concrete.
- (4) Longitudinal and lateral spacing of studs with respect to each other and to edges of beam or girder flanges shall not vary more than 1/2 inch (13 mm) from the dimensions the plans show, except that the engineer will allow a variation of one inch (25 mm) if required to avoid obstruction of other attachments on the beam, or if welding a new stud to replace a defective one. Ensure a minimum distance from the edge of a stud shank to the edge of a beam or plate of one inch (25 mm) exists, but preferably 1 1/2 inch (38 mm) or more.
- (5) Inform the engineer promptly of any changes in the welding procedure at any time during construction.
- (6) If welding the studs reduces their height to less than normal, immediately stop welding and do not resume until correcting the cause.
- (7) After welding the studs to the beams, perform a visual inspection and give each stud a light blow with a hammer. Strike with a hammer and bend 15 degrees from the correct installation axis. Any stud: without a 360-degree end weld, that does not ring if given a light blow with a hammer, repaired by welding, or that is reduced to less than normal in height due to welding. In cases of a defective or a repaired weld, bend the stud 15 degrees in the direction that places the weld's defective portion in the greatest tension. Replace studs that crack either in the weld or in the shank.
- (8) The engineer may select additional studs to subject to the bend test specified above.

506.3.21 Mill Inspection and Tests

- (1) Unless directed otherwise, the fabricator of structural steel shall furnish the engineer with 2 copies of a certified report of test or analysis showing both physical and chemical tests of the material for each heat of material. Submit these inspection and test reports to the inspector for examination and before requesting the fabrication shop inspection or when requesting the material prepayment inspection. The engineer will not approve prepayment for material that mill test reports are not submitted.

506.3.22 Shop Inspection

- (1) The engineer may inspect all structural steel and miscellaneous metals furnished.
- (2) Give the engineer ample notice of the beginning of the shop work.
- (3) Before requesting an inspector, the fabricator shall submit a list of main stress-carrying members and the heat number of the material from which fabricating the member. Preserve the heat number, as marked by the rolling mill, for identification by the inspector. If fabrication hides, cuts off, or obliterates otherwise the original number or marking, the fabricator shall paint the number on the material at a conspicuous location.
- (4) Furnish facilities in the shop for inspecting material and work quality and allow the inspectors necessary access to all parts of the work. The facilities shall include adequate office space at the fabricating plant for the inspector's use during fabrication, assembly, cleaning, and painting. At the plants of all major fabricators, as the engineer determines, ensure this office space has at least 100 square feet (9.3 m²) of floor space and is furnished with at least 2 desks, or a desk and table, a file case, and other necessary

furniture. Provide adequate lighting, heating, and ventilation and ensure cleanliness. Provide office space that is a completely partitioned area separated from the fabricator's activities, has a separate door equipped with a suitable lock and key; or is part of a larger facility set aside for the exclusive use of outside inspection personnel. Make available telephone service and adequate sanitary facilities in the immediate area. The engineer may revise the foregoing requirements to accommodate the number of inspectors necessary to inspect the volume of work.

- (5) The inspector may reject any material or work that does not conform to the specification requirements.
- (6) The inspector's acceptance of any material or finished members will not preclude their subsequent rejection if found defective.
- (7) Inspection at the shop is intended as a means of facilitating the work and avoiding error. It shall not relieve the contractor of responsibility for imperfect material, or technique, or for replacing the same.

506.3.23 Marking and Shipping

- (1) Paint or mark each member with an erection mark for identification and furnish an erection diagram showing the erection marks. Mark members weighing more than 3 tons (3 Mg) with their weight. Load structural members on trucks or cars in a manner that transports and unloads them at their destination without being excessively stressed, deformed, or damaged otherwise. Ship all girders and rolled beams in a standing position, maintain this position in subsequent operations. The fabricator may ship haunched sections of built-up girders in an inverted position.
- (2) Ship high strength bolts, nuts, and washers (if required) from each rotational-capacity lot in the same container. If there is only one production lot number for each size of nut and washer, the supplier may ship the nuts and washers. Pack separately non-high-strength bolts of one length and diameter, and the loose nuts and washers supplied for each size of bolt, except ship zinc coated bolts, nuts, and washers of the same size in the same containers. Ship bolts, nuts, washers, pins, and small parts in boxes, crates, kegs, or barrels, but the gross weight of any container shall not exceed 300 pounds (136 kg). Clearly and permanently, mark a list on the outside of each shipping container that describes the contained material. Clearly and permanently, mark on the outside of each shipping container of bolts, nuts and washers the rotational-capacity lot number, in addition to a list and description of the contained material.

506.3.24 Handling and Storing

- (1) Place material to be stored on skids above the ground. Keep it clean and properly drained. Place girders and beams upright, shore, and tie or brace to preclude tipping or overturning if exposed to high winds. Support long members, such as columns and chords, on skids placed near enough together to prevent injury from deflection. Loss of any material, or any damage caused after receiving it is the contractor's responsibility.
- (2) Store bolts, nuts, and washers in original containers and protect them from dirt and moisture until used.

506.3.25 Field Inspection

- (1) Erections are subject to inspection and the contractor shall furnish facilities for inspection of material and work quality. The inspector will inspect material and work quality not previously inspected after its delivery to the work site.

506.3.26 Falsework

- (1) The contractor may furnish previously used materials for falsework. Ensure proper design, construction, and maintenance of falsework in order to handle the loads placed upon it. Falsework shall provide the required construction camber.
- (2) Submit detailed plans for falsework to the engineer if requested. The engineer's approval of these plans, or acceptance in work constructed according to them shall not relieve the contractor of responsibility for successful erection or satisfactory results.
- (3) If building falsework over a stream or lake subject to boating use, construct it to provide horizontal and vertical clearance adequate for passage of rowboats and small powerboats. If building falsework over a highway or street used by traffic provide a minimum clearance, unless the plans or special provisions require otherwise, of 22 feet (6.71 m) horizontal and 13 feet 6 inches (4.12 m) vertical.
- (4) After completing the work, remove falsework piles down to at least 2 feet (600 mm) below streambed or finished ground line. Remove entirely any temporary bents, mudsills, and footings.
- (5) Do not attach overhang bracket form supports to the girder web.

506.3.27 Erection

- (1) Do not apply any part of the steel superstructure load to any concrete substructure unit until the concrete in that unit cures for at least 48 hours under favorable conditions. Do not apply loads to beams of open-type structure units until the end of the required period for falsework support of these beams.
- (2) Unless specified otherwise the minimum number of pickup points are as follows:

GIRDER LENGTH	MINIMUM NUMBER OF PICKUPS
0-50 feet (0-15 m)	1
50 feet and over (15 m and over).....	2 or more

- (3) Use an appropriate balance beam or spreader bar for 2 or more pickup points with a single crane. Locate pickup points to avoid damage to the girder and to balance the load at each point.
- (4) The contractor shall not place any bent or twisted member until correcting its defects. The engineer will reject any members seriously damaged in handling or transporting.

506.3.28 Straightening Bent Material

- (1) Perform straightening of plates and angles or other shapes by methods not likely to produce fracture or other injury. Unless the engineer allows, do not heat the metal; if the engineer does allow, then do not heat to a temperature higher than 1200 F (649 C) (a dull red) and the operation by temperature-indicating crayons, liquids, or bimetal thermometers.
- (2) Ensure that parts to be heat straightened are substantially free of stress and external forces, except for stresses resulting from mechanical means used in the application of heat. After heating, cool the metal as slowly as possible away from drafts. Do not use water for cooling.
- (3) After straightening a bend or buckle, inspect the metal surface carefully for evidence of fracture.

506.3.29 Field Assembling and Bolting

- (1) Conform to the foregoing requirements for shop assembling. Make field connections, unless specified otherwise, with high strength bolts as specified in [506.3.12](#).
- (2) Unless the engineer allows, do not use a burning torch to make adjustments or cuts as an aid to field assembling.
- (3) Before beginning the field bolting on a continuous span, adjust the span and the immediately adjacent continuous spans to the correct grade, construction camber, and alignment.
- (4) Complete field bolting, except for compression joints in trusses, connections for laterals and railings, and connections for those nominal members the plans or contract specifically designates, before releasing and swinging free any part of the span from its supporting falsework.
- (5) Swing the span free from falsework before making connections for laterals.
- (6) After placing and curing the concrete floor, and sidewalks if any, on all spans of the structure, make the connections for those nominal members as the plans show or the contract specifically designates. Erect, align, and fasten the railings in place.
- (7) For splices and field connections using high strength bolts, fill at least 25 percent of the holes with cylindrical erection pins before placing the permanent high-strength bolts. Fill at least 25 percent of the holes with erection bolts for temporary connections. Place all bolts before proceeding with final tightening as specified in [506.3.12](#).
- (8) Ensure that erection bolts are the same nominal diameter as the high strength bolts and that cylindrical erection pins are 1/32 inch (0.8 mm) larger).
- (9) The contractor may assemble girders or portions of girders or other units on cribbing to the required blocking before erection or placement in the structure, if the engineer approves. Any necessary adjustments in the joints or splices of the assembled units after erection or placement are the contractor's responsibility.

506.3.30 Bearings and Anchorage

- (1) Do not place masonry bearing plates on bridge seat bearing areas that are improperly finished, deformed, or irregular.

- (2) Set the bearing plates level in exact position and have full and even bearing on the masonry. Unless required otherwise, place them on bearing pads conforming to [506.2.6](#).
- (3) After properly aligning and finally connecting the steel in the superstructure, drill the holes in the concrete and set the anchor bolts except if the bolts are built into the masonry.
- (4) Set anchor bolts in an engineer-approved, premixed, non-shrink commercial grout, except during freezing weather, or in an epoxy conforming to [415.2.6](#). Place the grout according to the manufacturer's instructions and fill the hole before ramming the bolt in place. Overfill the hole with just enough grout or epoxy to produce a watertight fit when the bearing plate is installed. Remove excess grout or epoxy from the bolt and bearing area.

506.3.31 Cleaning of Surfaces

506.3.31.1 General

- (1) Blast clean the surfaces of all structural steel to remove rust, mill scale, dirt, oil, or grease and other foreign substances until obtaining the specified finish.
- (2) Blast clean all non-machined surfaces of a casting before machining the casting.

506.3.31.2 Coated Surfaces

- (1) As specified in [506.3.32](#), blast clean all structural steel and all ferrous metal products to be coated as specified for blast cleaning in [517.3.1.3.3](#) to a near-white finish according to SSPC-SP 10. Blast clean steel that will be encased in concrete to SSPC-SP 6 standards or cleaner.

506.3.31.3 Unpainted Weathering Steel

- (1) Blast clean all surfaces of weathering steel, unless designated for coating, until obtaining a finish as described for commercial blast cleaning in SSPC-SP 6. Perform blast cleaning with sand, grit or steel shot as described for SSPC-SP 6.
- (2) Keep or place the following markings on material shipped to the field:
 - Weights of members weighing 3 tons (3 Mg) or more.
 - Piece marks.
 - Matchmarks if required.
- (3) Place weight markings on interior surfaces of exterior girders and on interior girders in locations that are inconspicuous after erection and their removal are not required except if the engineer directs.
- (4) After erection, clean all steel in the completed structure by hand, until free of oil, dirt, grease, mortar and other foreign substances.

506.3.32 Painting Metal

- (1) Unless the contract provides otherwise, apply 3 coats of paint to all structural steel and ferrous metal products. Furnish and apply paints according to the epoxy system or as specified in the special provisions. The requirements for this system are set forth in [section 517](#).
- (2) For structural steel, including weathering steel, and miscellaneous metals that will be encased in concrete, paint as specified in [517.3.1](#).
- (3) Apply one coat of inorganic zinc-rich primer and one shop coat of high-build epoxy paint to the end 6 feet (1.8 m) of all structural weathering steel at the abutments, the 6 feet (1.8 m) on each side of piers, joints, downspouts, and hinges excluding the exterior faces of the exterior girders, and zinc-coated bearings in contact with weathering steel. Use a brown colored high-build epoxy coat. Apply one coat of zinc-rich paint to surfaces of expansion joint assemblies and other surfaces not in contact with the weathering steel but inaccessible after assembly or erection.
- (4) Do not paint structural steel to be welded before completing welding. If welding only in the fabricating shop and subsequently erecting by bolting, coat it after completing shop welding. Apply one coat of weldable primer or other engineer-approved protective coating to steel surfaces to be field welded after completing shop welding and shop fabrication. Protect machine-finished surfaces that do not receive a paint or zinc coating from contamination during the cleaning and painting process.
- (5) Upon fabrication and acceptance, coat pins and pinholes with a plastic or other engineer-approved coating before removing from the shop.

- (6) Mark members weighing 3 tons (3 Mg) or more with their weights on areas that will be encased in concrete, or paint with a compatible paint on zinc-rich primer, or mark with soapstone on an epoxy-coated surface. Wait until material is dry, inspected and approved for shipment before loading for shipment.

506.3.33 Name Plates

- (1) Furnish and install nameplates conforming to [506.2.4](#).
- (2) Furnish and place one nameplate on each structure at the location the plans show.
- (3) If attaching nameplates to the structure steel, attach it with of 2 bolts conforming to the requirements of [506.2.4](#). If required to attach the plate to concrete, attach it as specified in [502.3.11](#).
- (4) No permanent plates or markers, other than the above designated nameplate and specified benchmarks, are allowed on any structure, unless the engineer approves otherwise.

506.3.34 Steel Diaphragms

- (1) Install steel diaphragms as the plans show.

506.4 Measurement

- (1) The department will measure Structural Steel Carbon, Structural Steel HS, the Castings bid items, Forgings Steel Carbon, Lubricated Plates Bronze, and the Sheet bid items by the pound acceptably completed. The department will measure quantities for payment based on those shown on the engineer-approved bridge plans.

- (2) The department will use the following unit weights to compute the weight of metals:

MATERIAL	UNIT WEIGHT
Steel: structural carbon, high strength structural, castings, or forgings.....	490 lb/ft ³ (7849 kg/m ³)
Bronze plate and castings	536 lb/ft ³ (8586 kg/m ³)
Sheet copper 0.02 inches (0.5 mm) thick	0.93 lb/ft ² (4.54 kg/m ²)
Sheet zinc No. 12 zinc gauge, 0.028-inch (0.71 mm)	1.05 lb/ft ² (5.13 kg/m ²)
Sheet zinc No. 18 zinc gauge, 0.055-inch (1.40 mm)	2.06 lb/ft ² (10.06 kg/m ²)
Sheet zinc No. 20 zinc gauge, 0.070-inch (1.78 mm)	2.62 lb/ft ² (12.79 kg/m ²)

- (3) Compute the weights of all rolled shapes based on their nominal weights and dimensions. Compute the weights of all plates, including those of zinc and copper based on their nominal weights and dimensions and make full deduction for all cuts except interior cuts, beveled cuts on edges for butt welding, and cuts made by machining to provide other than plane surfaces.
- (4) The department will not include the weight of paint, zinc coating, or weld metal in the computed weight.
- (5) The department will include the weight of heads, nuts, single washers, and threaded stick-through of all high strength bolts and heads, based on the following weights:

BOLT DIAMETER	WEIGHT PER 100 BOLTS
1/2-inch.....	19.7 pounds
5/8-inch.....	31.7 pounds
3/4-inch.....	52.4 pounds
7/8-inch.....	80.4 pounds
1-inch.....	116.7 pounds
1 1/8-inch.....	165.1 pounds
1 1/4-inch.....	212.0 pounds
METRIC BOLT SIZE	MASS PER 100 BOLTS
M16.....	14.6 kg
M20.....	26.2 kg
M22.....	38.1 kg
M24.....	47.3 kg
M27.....	66.9 kg
M30.....	86.0 kg

- (6) The department will not measure load indicator washers for payment.

- (7) Compute the weight of castings from their dimensions and add 3 percent for fillets and overruns, however, if the scale weight of any casting is less than the computed weight, the department will pay for the weight of that casting at the scale weight. If the scale weight of any casting is less than 97 percent of the computed weight, the department may reject the casting.
- (8) If the computed weights of metals, from engineer-approved shop drawings, varies more than one percent from those the engineer-approved bridge plans show for an individual structure, the department will base quantities for that structure on those computed from the engineer-approved shop drawings. The exception is if the contractor elects, with the engineer's permission, to use equivalent sections of greater weight than those the engineer-approved bridge plans show, then the contractor shall bear all additional costs.
- (9) The department will measure Bearing Pads by the square foot acceptably completed.
- (10) The department will measure Bearing Pads Elastomeric Non-laminated and Bearing Pads Elastomeric Laminated as each individual pad acceptably completed.
- (11) The department will measure the Welded Stud Shear Connectors bid items as each individual unit acceptably completed. The department will measure the total number of connectors incorporated in the work and accepted.
- (12) The department will measure the Steel Diaphragms bid items as each individual diaphragm acceptably completed.
- (13) The department will measure the Bearing Assemblies bid items as each individual unit acceptably completed. The department will measure the total number of assemblies incorporated in the work and accepted.

506.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
506.0105	Structural Steel Carbon	LB
506.0605	Structural Steel HS	LB
506.1000 - 1099	Castings (type)	LB
506.1105	Forgings Steel Carbon	LB
506.1405	Lubricated Plates Bronze	LB
506.1500 - 1599	Sheet (type)	LB
506.2105	Bearing Pads	SF
506.2605	Bearing Pads Elastomeric Non-Laminated	EACH
506.2610	Bearing Pads Elastomeric Laminated	EACH
506.3000 - 3099	Welded Stud Shear Connectors (7/8 x inch)	EACH
506.4000	Steel Diaphragms (structure)	EACH
506.5000	Bearing Assemblies Fixed (structure)	EACH
506.6000	Bearing Assemblies Expansion (structure)	EACH

- (2) Payment for Structural Steel Carbon, Structural Steel HS, the Castings bid items, Forgings Steel Carbon, Lubricated Plates Bronze, and the Sheet bid items is full compensation for providing, fabricating, casting, machining or otherwise preparing, transporting, and erecting all materials; for providing name plates; and for furnishing radiographic films to the inspector.
- (3) Payment for Bearing Pads is full compensation for providing and placing the pads.
- (4) Payment for Bearing Pads Elastomeric Non-Laminated and Bearing Pads Elastomeric Laminated is full compensation for providing the pads, and for testing, if required.
- (5) Payment for the Welded Stud Shear Connectors bid items is full compensation for providing the shear connectors.
- (6) Payment for the Bearing Assemblies bid items is full compensation for providing bearing assemblies, including the anchor bolts, and for fabricating and installing the assemblies.
- (7) Payment for the Steel Diaphragms bid items is full compensation for providing, fabricating, zinc coating, transporting, and erecting.

- (8) The contractor shall perform miscellaneous work that the plans show or is specified otherwise and included within the scope of this contract but not listed as bid items as a part of and included in the contract price for other bid items, except as follows:
- If the contract does not contain the Welded Stud Shear Connectors, Bearing Assemblies Fixed, or Bearing Assemblies Expansion bid item, and the contract requires this work, the department will pay for this work as Structural Steel Carbon.
 - The department will pay separately for painting structural steel and miscellaneous metals under the Painting Epoxy System bid item as specified in [517.5](#), or absent the bid item as extra work.

SECTION 507 TIMBER STRUCTURES

507.1 Description

- (1) This section describes furnishing, framing, treating, delivering, erecting, and painting if required, all treated lumber and timber required for timber bridges and other timber structures, or lumber and timber parts of other bridges or structures.

507.2 Materials

507.2.1 General

- (1) Furnish all hardware required to erect the lumber and timber. Furnish materials conforming to the following:
 - Structural steel.....[506.2](#)
 - Miscellaneous metals[506.2](#)
 - Paint and painting [section 517](#)

507.2.2 Lumber and Timber

507.2.2.1 General

- (1) If ordering lumber and timber in multiple lengths, grade them after cutting to length.
- (2) The engineer will only accept pieces that are sound and free from decay. The engineer will reject pieces exceptionally light in weight.
- (3) There is no heartwood requirement for lumber and timber treated with a preservative and no limit on the amount of sapwood it can contain. Preservative treatment of lumber and timber shall conform to [507.2.2.6](#).
- (4) Measure and limit knotholes and other holes as specified for knots under [508.2.2.3.2](#). The engineer will reject all pieces with unsightly holes. The engineer will not accept lumber and timber with cluster knots and knots in groups.

507.2.2.2 Wood Species

- (1) Furnish one of the following species for treated structural lumber and timber:
 - Douglas Fir-Coastal
 - Southern Pine
 - Hem-Fir

507.2.2.3 Manufacture

- (1) Ensure all structural lumber and timber are straight, sawed square at the ends, and have opposite surfaces parallel.
- (2) Saw rough structural lumber and timber to the nominal dimensions specified in [507.2.2.3\(4\)](#). Occasional slight variation is permissible, however, ensure that the specified minimum dressed dimensions are met everywhere along the length.
- (3) The manufacturer may surface structural lumber and timber ordered rough, if thicker than specified, to a rough stock thickness.
- (4) Manufacture lumber and timber according to the nominal and minimum dimensions in the following table:

AMERICAN STANDARD SIZES FOR STRESS-GRADED and NON-STRESS-GRADED CONSTRUCTION LUMBER^[1]

ITEM	THICKNESS			FACE WIDTH		
	NOMINAL inches (mm)	MINIMUM DRESSED		NOMINAL inches (mm)	MINIMUM DRESSED	
		DRY inches (mm)	GREEN inches (mm)		DRY inches (mm)	GREEN inches (mm)
BOARDS	1 (25)	3/4 (19)	25/32 (20)	2 (51)	1 1/2 (38)	1 9/16 (40)
	1 1/4 (32)	1 (25)	1 1/32 (26)	3 (76)	2 1/2 (64)	2 9/16 (65)
	1 1/2 (38)	1 1/4 (32)	1 9/32 (33)	4 (102)	3 1/2 (89)	3 9/16 (90)
				5 (127)	4 1/2 (114)	4 5/8 (117)
				6 (152)	5 1/2 (140)	5 5/8 (143)
				7 (178)	6 1/2 (165)	6 5/8 (168)
				8 (203)	7 1/4 (184)	7 1/2 (191)
				9 (229)	8 1/4 (210)	8 1/2 (216)
				10 (254)	9 1/4 (235)	9 1/2 (241)
				11 (279)	10 1/4 (260)	10 1/2 (267)
				12 (305)	11 1/4 (286)	11 1/2 (292)
				14 (356)	13 1/4 (337)	13 1/2 (343)
				16 (406)	15 1/4 (387)	15 1/2 (394)
DIMENSION	2 (51)	1 1/2 (38)	1 9/16 (40)	2 (51)	1 1/2 (38)	1 9/16 (40)
	2 1/2 (64)	2 (51)	2 1/16 (52)	3 (76)	2 1/2 (64)	2 9/16 (65)
	3 (76)	2 1/2 (64)	2 9/16 (65)	4 (102)	3 1/2 (89)	3 9/16 (90)
	3 1/2 (89)	3 (76)	3 1/16 (78)	5 (127)	4 1/2 (114)	4 5/8 (117)
	4 (102)	3 1/2 (89)	3 9/16 (90)	6 (152)	5 1/2 (140)	5 5/8 (143)
	4 1/2 (114)	4 (102)	4 1/16 (103)	8 (203)	7 1/4 (184)	7 1/2 (191)
				10 (254)	9 1/4 (235)	9 1/2 (241)
				12 (305)	11 1/4 (286)	11 1/2 (292)
				14 (356)	13 1/4 (337)	13 1/2 (343)
				16 (406)	15 1/4 (387)	15 1/2 (394)
TIMBERS	5 (127) and thicker	1/2 (13) less than nominal	1/2 (13) less than nominal	5 (127) and wider	1/2 (13) less than nominal	1/2 (13) less than nominal

^[1] This table uses nominal sizes for convenience. They do not represent actual sizes.

507.2.2.4 Stress Grading Requirements

- (1) Furnish structural lumber and timber conforming to the stress grade the plans, specifications, or contract shows.
- (2) Grade all lumber and timber required to conform to a specific stress grade according to AASHTO M168.
- (3) Ensure that lumber and timber required to conform to a specific stress grade shows a copyrighted stamp on each piece designating the inspecting agency, inspector, or mill and grade, or furnish a certificate of inspection to the engineer for untreated material, or to the department inspector at the treating plant for treated material. Include the kind and grade of material and the name of the grading agency.

507.2.2.5 Structural Purposes

- (1) If the plan or contract does not designate a required stress grade, conform to the minimum stress grade, and associated allowable unit stress, for lumber and timber used for various structural components as follows:

STRESS RATING AT 19 PERCENT MAXIMUM MOISTURE

USE 1750 psi (12 070 kPa) f_b STRUCTURAL JOIST AND PLANK GRADE FOR:

Joists; 4 inches (102 mm) or less.

Sidewalk railing posts.

Bulkhead planks.

Floor planks, wearing.

Rails.

Laminated or strip flooring.

USE 1750 psi (12 070 kPa) f_b STRUCTURAL BEAM AND STRINGER GRADE FOR:

Stringers; 5 inches (127 mm) or more.	Sills.
Roadway railing posts.	Caps.

USE 1200 psi (8 280 kPa) f_b STRUCTURAL JOIST AND PLANK GRADE FOR:

Nailing strips; 4 inches (102 mm) or less.	Subfloor planks.
Bracing; sway and longitudinal.	Subfloor sheathing.
Cross bridging.	Retaining pieces.
Cleats.	Scupper blocks.
Fire stops.	Sidewalks.

USE 1200 psi (8 280 kPa) f_b STRUCTURAL BEAM AND STRINGER GRADE FOR:

Nailing strips; 5 inches (127 mm) or more.	Grillage.
Mud Sills.	

USE 1200 psi (8 280 kPa) f_c STRUCTURAL POST AND TIMBER GRADE FOR:

Posts with longitudinal load.	Wheel guards.
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USE THE ENGINEER DESIGNATED STRESS GRADE FOR ALL OTHER LUMBER AND TIMBER.

507.2.2.6 Preservative Treatments

507.2.2.6.1 General

- (1) Use the pressure process to apply preservative treatment to structural lumber and timber, unless specified otherwise in the contract or special provisions, according to AASHTO M 133. If using copper naphthenate, preservative treatment, conform to AWPA P8. Unless the engineer directs otherwise, inspect the material before treatment. The engineer will accept material after treatment based on: its condition before treatment, inspection of the treatment procedure substantiated by plant records, on the condition of the material after treatment, and on absorption, penetration, borings, and visual inspection.
- (2) The department may re-inspect material after delivery, and may reject material that does not comply with the specifications.
- (3) Unless the contract specifies otherwise, furnish structural lumber and timber treated with one of the preservatives specified in [507.2.3](#), except as follows:
 - Do not treat coastal Douglas fir with chromated copper arsenate or ammoniacal copper quat, and do not treat hem-fir with copper naphthenate.
 - If using pentachlorophenol, use a solution with 5 percent pure pentachlorophenol, by weight, of the total solution. Use the heavy petroleum solvent, except if painting the treated surface then use the light petroleum solvent.

507.2.2.6.2 Treatment Preparation

- (1) If possible, sort the material into one kind, or designated group of kinds of wood, and into pieces approximately equal in size, moisture, and sapwood content; and separate to ensure the treating medium contacts all surfaces.
- (2) If possible, perform all adzing, boring, chamfering, framing, gaining, mortising, surfacing, etc., before treatment.

507.2.2.6.3 Preservative Quantity

- (1) Unless the proposal or the plans specify otherwise, use the minimum quantity of preservative material retained, and the minimum penetration specified in AWPA Standard C2 for Soil Contact for the species.
- (2) Determine the minimum net retention according to AWPA Standard M2.

507.2.3 Wood Preservatives

- (1) Use wood preservatives conforming to the following standards:

Creosote-coal tar solution	AASHTO M 133
Pentachlorophenol	AASHTO M 133
Petroleum solvents used in pentachlorophenol solutions	AASHTO M 133
Petroleum solvents used in copper naphthenate solutions	AWPA P9
Chromated copper arsenate solution	type A, B, or C as specified in AASHTO M 133

Ammoniacal copper arsenate solution	AASHTO M 133
Ammoniacal copper zinc arsenate solution	AASHTO M 133
Copper naphthenate solution.....	AWPA P8
Ammoniacal copper quat solution.....	type D as specified in AWPA P5

507.2.4 Coal-Tar Pitch

- (1) Furnish coal-tar pitch for treating cuts or abrasions in treated lumber and timber conforming to ASTM D 450, type II.

507.2.5 Timber Connectors

- (1) Zinc coat connectors for timber structures, except malleable iron connectors, according to AASHTO M 111.

507.2.5.1 Split Ring Connectors

- (1) Manufacture split rings of 2 1/2 inch (64 mm) and 4 inch (102 mm) inside diameter from hot-rolled low carbon steel conforming to AASHTO M 169 grade 1010. Each ring shall form a closed, true circle with the principal axis of the cross section of the ring metal parallel to the geometric axis of the ring. Bevel the metal section from the central portion toward the edges to a thickness less than midsection. Provide one tongue and slot cut in the perimeter.

507.2.5.2 Shear Plates

- (1) Use hot-rolled low carbon steel conforming to AASHTO M 169 Grade 1010 for pressed-steel shear plates.
- (2) Cast malleable-iron shear plates from malleable iron conforming to ASTM A47.

507.2.6 Hardware

- (1) For machine bolts, timber bolts, drift bolts, lag screws, dowels, rods, and spikes longer than 6 inches (150 mm) left in the finished work, conform to the material specifications for structural steel or miscellaneous metals specified in [507.2.1](#).
- (2) Provide square heads and nuts for machine bolts unless specified otherwise. Ensure the threads on all bolts are U.S. Standard and not less than 2 1/2 times the diameter of the bolt in length.
- (3) Provide gray or malleable iron casting washers, or cut them from steel plates. Use washers with holes that are not more than 1/8 inch (3 mm) larger than the bolt diameter. Use ogee type gray iron washers with a diameter at least 3 1/2 times the bolt diameter, and a thickness equal to the bolt diameter. Use malleable iron washers with properly proportioned ribs to develop the bolt's full strength. The malleable iron washer diameter shall at least equal 3 1/2 times the bolt diameter, and have a thickness equal to 1/2 the bolt diameter. Use plate washers with a diameter at least 3 1/2 times the bolt diameter and, unless specified otherwise, a thickness of at least 1/4 inch (6 mm).
- (4) Provide gray or malleable iron casting packing spools or separators, or cut them from steel plates. Ensure the hole diameter is not more than 1/8 inch (3 mm) larger than the packing bolt diameter.
- (5) Use oval-headed barbed car nails or ring shank nails for nails and spikes up to and including 60d. For all spikes over 60d, use the type and size specified. Unless specified otherwise, use nails no shorter than 2 1/2 times the thickness of the material being driven through. If clinching nails, ensure they project at least one inch (25 mm) before clinching.
- (6) Zinc coat or cadmium plate all hardware unless specified otherwise. The zinc coating shall conform to the quality and weight in ASTM A 153. The cadmium coating shall conform to class 12, type III of ASTM B 766.

507.3 Construction

507.3.1 Quality

- (1) Ensure first class product quality throughout. Drive nails and spikes with just sufficient force to set the heads flush with the wood surface. Ensure that wood surfaces are free from deep or frequent hammer marks.
- (2) The product quality on all metal parts shall conform to the requirements specified in [section 506](#) for steel bridges.

507.3.2 Storage

- (1) Store lumber and timber in neat piles, on suitable blocking or supports, and above the ground. Clear the ground underneath and near all piles of weeds and rubbish.
- (2) Close-stack treated material to prevent long timbers, or those of small cross section, from sagging or becoming crooked. If anticipating an extended storage period and the material merits protection from the direct sunlight or possible fire hazard, cover the top of the pile with a layer of tar paper, or equal, and spread not less than one inch (25 mm) of sand or earth over the cover.

507.3.3 Handling

- (1) Handle treated lumber and timber carefully to avoid breaking through the treated portions and exposing untreated wood. Do not use chains, peaveys, cant hooks, pickaroons, timber dogs, pike poles, or other pointed tools on treated lumber and timber, use padded or non-metallic slings instead.

507.3.4 Framing and Boring

507.3.4.1 General

- (1) Cut and frame all lumber and timber to a close fit. If possible, cut, frame, and bore treated timbers before treatment.

507.3.4.2 Holes for Bolts, Dowels, Rods and Lag Screws

- (1) Bore the holes for round drift bolts and dowels with a bit 1/16 inch (2 mm) less in diameter than the bolt or dowel used. Ensure that the diameter of holes for square drift bolts or dowels equals the bolt or dowels least dimension.
- (2) Bore the holes for machine bolts with a bit the same diameter as the bolt.
- (3) Bore the holes for rods with a bit 1/16 inch (2 mm) greater in diameter than the rod.
- (4) Bore the holes for lag screws with a bit not larger than the body of the screw at the thread base.

507.3.4.3 Countersinking

- (1) Perform countersinking if smooth faces are required.

507.3.4.4 Connectors

- (1) If using timber connectors, use the type and size the plans show. Install split ring connectors in precut grooves to form a snug fit, or as the manufacturer recommends.

507.3.5 Temporary Attachment

- (1) If attaching forms or temporary braces to treated timber with nails or spikes, with the engineer's approval, fill the holes by driving zinc coated nails or spikes flush with the surface, or by plugging as required for bolt holes.

507.3.6 Bolts and Washers

- (1) Use a washer the size and type specified under all bolt heads, except timber bolts or bolts with button-type heads, and also under lag screws and nuts that would otherwise come in contact with wood.

507.3.7 Treating Cuts, Abrasions, and Holes in Treated Lumber and Timber

- (1) Carefully trim and cover all abrasions, holes, and cuts made in treated lumber and timber with a compatible preservative material. Use preservatives and application methods specified in AWWPA Standard M4. Apply the preservative in 3 applications; wait at least 2 hours between applications.
- (2) Carefully trim and then fill all holes made in treated material with a 2 percent copper naphthenate solution conforming to [507.2.3](#), or with hot creosote-coal tar solution conforming to [507.2.3](#), so that the solution saturates the entire area surrounding the hole.
- (3) Treat all unfilled holes in treated lumber and timber, except for countersinking recesses, as specified above and then plug with treated plugs.
- (4) Fill all countersinking recesses that form pockets that might retain water with a 2 percent copper naphthenate solution, or with hot coal-tar pitch, type II, after placing the bolt or screw.

507.3.8 Framed Bents

507.3.8.1 Mudsills

- (1) Firmly, and evenly bed mudsills to solid bearing and tamp in place.

507.3.8.2 Concrete Pedestals

- (1) Finish the concrete pedestals for supporting framed bents so the sills or posts bear evenly on them. If casting them, set dowels in them of not less than 3/4 inch (19 mm) diameter and projecting at least 6 inches (150 mm) above the tops of the pedestals, for anchoring the sills or posts.

507.3.8.3 Sills

- (1) Ensure that sills bear true and even on mudsills, piles, or pedestals. Drift bolt the sills to mudsills, or piles, with bolts at least 3/4 inch (19 mm) in diameter and extending into the mudsills or piles at least 6 inches (150 mm). If possible, remove all earth from contact with sills so air circulates freely around them.

507.3.8.4 Posts

- (1) Ensure that posts bear evenly on cap and sill. Fasten posts to pedestals with dowels at least 3/4 inch (19 mm) in diameter and extending at least 6 inches (150 mm) into the posts.
- (2) Fasten posts to sills by one of the following methods, as the plans show:
 - With dowels not less than 3/4 inch (19 mm) diameter extending at least 6 inches (150 mm) into posts and sills.
 - With drift bolts not less than 3/4 inch (19 mm) diameter driven diagonally through the base of the post and extending at least 9 inches (225 mm) into the sill.

507.3.9 Caps

- (1) Place the timber caps so the ends align, to secure an even and uniform bearing over the tops of the supporting posts or piles. Secure all caps with drift bolts at least 3/4 inch (19 mm) in diameter and extending at least 9 inches (225 mm) into the posts or piles. Place the drift bolts approximately in the center of the post or pile.

507.3.10 Bracing

- (1) Ensure that all bracing bears firmly against the pile or cap that it is bolted. Provide and place shims as necessary to avoid bending the bracing more than one inch (25 mm) out of line after drawing the bracing bolts tight. Furnishing and placing shims are incidental to this work. If the opening between the bracing and the cap or pile is less than one inch (25 mm), there is no need for shims. If the opening between the bracing and the cap or pile is from one to 2 inches (25 to 50 mm), place 2 ogee washers with their narrow faces together on each bolt that passes through the opening. If the opening between the bracing and the cap or pile is over 2 inches (50 mm), use wooden shims of the proper thickness. Use wooden shims made of untreated white oak, or the treated material used in the structure. Do not use built-up wooden shims. Ensure each wooden shim is a single piece of lumber at least 4 inches (100 mm) wide and at least as long as the bracing is wide, measured along the cap or pile.
- (2) The contractor shall not adze, trim, or cut otherwise any treated member to avoid using the above-described shims.

507.3.11 Stringers

- (1) Size the stringers at bearings and position so that knots near edges are in the top of the stringers.
- (2) Outside stringers may have butt joints but, lap interior stringers to take bearing over the full width of the floor beam or cap at each end. Separate the lapped ends of stringers by at least 1/2 inch (13 mm) for air circulation and securely fasten by drift bolting if specified. If stringers are 2 panels in length, stagger the joints.
- (3) Neatly and accurately frame cross bridging between stringers, and securely toe nail with at least 2 nails in each end. Ensure all cross bridging members bear at each end against the sides of stringers. Unless specified otherwise in the contract, place cross bridging at the center of each span.

507.3.12 Plank Floors

- (1) Use treated lumber and timber in plank floors.

- (2) Single plank floors consist of a single thickness of plank supported by stringers or joists. Use planks surfaced on one side and one edge (S1S1E). Lay the planks with the surfaced side down and with close joints. Spike each plank securely to each joist. Lay planks at right angles to the centerline of roadway. Grade the thickness of the planks carefully and lay them so that no 2 adjacent planks vary by more than 1/16 inch (2 mm) in thickness.
- (3) Two-ply plank floors consist of 2 layers of flooring supported by stringers or joists. Use planks surfaced on one side and on one edge (S1S1E). Lay the planks with the surfaced side down and with close joints. Lay the top course diagonally or parallel to the centerline of roadway, as specified, and fasten each floor plank securely to the lower course or to the joist. Grade the thickness of the planks carefully and lay them so that no 2 adjacent planks vary by more than 1/16 inch (2 mm) in thickness. Stagger joints by at least 3 feet (900 mm). If placing the top flooring parallel to the centerline of the roadway, take care to securely fasten the end of the flooring. At each end of the bridge, bevel the upper course of planks.
- (4) Spike side and retaining pieces at one-foot (300 mm) intervals and bolt at 3-foot (900 mm) intervals unless the plans indicate otherwise. Fasten scupper blocks to the retaining pieces by spikes and bolts through the wheel guards. Bolt the wheel guards in place as the plans indicate. Lay side retaining pieces and wheel guards true to line, parallel to the centerline of roadway, and flush with the edge of the subflooring.

507.3.13 Laminated or Strip Floors

- (1) Use 3-inch (76 mm) or thinner strips, surfaced to a uniform thickness (S1S) and, if specified, to a uniform width (S1S1E).
- (2) Place the strips of lumber on edge and at right angles to the centerline of roadway. Spike each strip to the adjacent strip at 2-foot (600 mm) intervals with spikes that stagger 8 inches (200 mm) with those in adjacent strips. Use spikes of sufficient length to pass through 2 strips and at least halfway through the third. Additionally, toe nail the strips to the stringers or nailing strips with 20d spikes, and stagger the nailing of successive strips to space spikes at least 6 inches (150 mm) along each stringer or nailing strip. Keep each strip vertical and tight against the preceding one with even bearing on all the supports. If the plans show, attach the strips securely to steel supports by department-approved zinc coated metal clips.

507.3.14 Wheel Guards and Railings

- (1) Unless specified otherwise, furnish wheel guards surfaced on one side and one edge (S1S1E) and rails and rail posts surfaced on 4 sides (S4S).
- (2) Lay the wheel guards in sections not less than 12 feet (3.7 m) long.

507.3.15 Fire Stops

- (1) Provide fire stops in the intervals as the plans show. They consist of wood diaphragms at least as thick as the flooring or sidewalk, are located over caps, and fill the openings between the joists completely.

507.3.16 Painting Lumber and Timber

- (1) Paint lumber and timber as specified under [517.3.2](#) unless the contract provides otherwise.
- (2) Painting lumber and timber is incidental to furnishing and erecting the lumber and timber.

507.4 Measurement

- (1) The department will measure Treated Lumber and Timber by the thousand feet board measure (MBM) acceptably completed. The department will compute quantities from the nominal sizes and from the lengths as framed and erected. The department will not make any allowance for waste.
- (2) The department will only measure lumber and timber that is a part of the completed work. The department will not measure falsework, forms, bracing, sheeting, or other lumber and timber used for erection purposes.

507.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
507.0200	Treated Lumber and Timber	MBM

- (2) Payment for Treated Lumber and Timber is full compensation for providing, framing, treating, placing, and painting if required; and for all materials and hardware required for erecting the lumber and timber

SECTION 508 TIMBER PILING

508.1 Description

- (1) This section describes furnishing, treating if required, driving, including preboring if required, and cutting off untreated timber test piling, treated timber test piling, untreated timber foundation piling, treated timber foundation piling, untreated timber trestle piling or treated timber trestle piling.

508.2 Materials

508.2.1 General

- (1) Furnish materials conforming to the following:

Structural steel.....	506.2
Miscellaneous metals	506.2
Creosote-coal tar solution	507.2.3
Coal-tar pitch, type II.....	507.2.4

508.2.2 Timber Piling

508.2.2.1 General

- (1) Furnish and use timber piling treated or untreated as the contract designates.
- (2) Except as specified otherwise, furnish class A piles.
- (3) Class B piles include all piles incorporated in a trestle, temporary or permanent, supporting railroad traffic.
- (4) Use class C piles only in falsework for structures supporting highway traffic, and for temporary structures supporting highway traffic.

508.2.2.2 Species

- (1) Untreated timber piling consists of any species of wood that withstands driving without showing excessive brooming or splitting.
- (2) Use treated timber piling from one of the following species:

Interior Douglas fir	Jack pine	Coastal Douglas fir	Western larch
Southern pine	Oak	Red pine	

508.2.2.3 Quality Requirements

- (1) Use class A and class B timber piles conforming to the following quality requirements:

508.2.2.3.1 Soundness

- (1) Use piles made of sound wood, free from decay, red heart, or insect attack. Southern yellow pine piles may have unsound knots not exceeding half the allowed size of a sound knot specified below, provided the unsoundness extends to not more than 1 1/2 inches (38 mm) depth and does not affect the adjacent trunk areas. The engineer may accept piles with sound turpentine scars undamaged by insects.

508.2.2.3.2 Knots

- (1) Sound knots in piles 50 feet (15 m) or less in length, and in 3/4 of the length from the butt of piles longer than 50 feet (15 m) are no larger than 4 inches (100 mm) or 1/3 the diameter of the pile at the point they occur, whichever is smaller. Sound knots in the remaining 1/4 of the length of piles longer than 50 feet (15 m) are no larger than 5 inches (125 mm) or 1/2 the diameter of the pile at the point they occur, whichever is the smaller. Measure the size of a knot by taking its diameter at right angles to the length of the pile. The engineer will not accept piles with unsound knots, except in southern pine piles as specified above. The sum of sizes of all knots in any one-foot (300 mm) length of the pile shall not exceed 2 times the size of the largest allowed single knot. The engineer will not accept piles with cluster knots. A cluster knot is 2 or more knots grouped together, with the fibers of the wood deflected around the entire unit. A group of single knots with fibers deflected around each knot separately is not a cluster, no matter how close the knots.

508.2.2.3.3 Holes

- (1) The engineer may allow holes less than 1/2 inch (13 mm) in average diameter provided the sum of the average diameters of all holes in any square foot (0.1 m²) of pile surface does not exceed 1 1/2 inches (40 mm).

508.2.2.3.4 Splits and Shakes

- (1) Ensure splits are not longer than the pile's butt diameter. Ensure that the length of any shake or combination of shakes in the outer 1/2 of the radius of the butt of the pile, if measured along the curve of the annual ring, is not greater than 1/3 the circumference of the butt of the pile.

508.2.2.3.5 Treated Piles, Sapwood

- (1) Ensure that piles intended for preservative treatment have at least one inch (25 mm) of sapwood at the butt end.

508.2.2.3.6 Heartwood and Density

- (1) If using untreated piling in exposed work, the diameter of the heartwood at the butt shall at least equal 80 percent of the diameter of the pile at the butt.

508.2.2.3.7 Peeling

- (1) Peel piles by removing all the outer bark and at least 80 percent of the inner bark, well distributed over the surface of the pile. If piles are receiving preservative treatment, then leave no strips of inner bark wider than 1/2 inch (13 mm).

508.2.2.3.8 Cutting and Trimming

- (1) Saw butts and tips square with the axis of the pile. Trim all knots and limbs, or smoothly cut flush with the surface of the pile, except, the contractor may hand trim knots flush with the surface of the swell surrounding the knot.

508.2.2.3.9 Straightness

- (1) A straight line drawn from the center of the butt to the center of the tip shall lie entirely within the body of the pile.

508.2.2.3.10 Taper

- (1) Cut piles above the butt swell and ensure a continuous taper from the point of butt measurement to the tip.

508.2.2.3.11 Twist of Grain

- (1) Twist of grain in any 20 feet (6 m) of length shall not exceed 1/2 of the circumference if measured at the midpoint of length.

508.2.2.4 Dimensions

- (1) Class A or class B timber piles, measured peeled or under the bark, shall conform to the table below, Dimensions of Timber Piles. Additionally, 10 percent of the class A piles in any lot may have circumferences 2 inches (50 mm) less than the tabulated minimum values, and 10 percent of the class B piles in any lot may have diameters 1/2 inch (13 mm) less than the tabulated minimum values.
- (2) The ratio of the maximum to the minimum diameter of the butt of any pile shall not exceed 1:2.
- (3) For class B piles, determine the diameter of a pile at a specified location where the pile is not exactly round either by the average of the minimum and maximum measured diameters, or by dividing the measured circumference by 3.14.

DIMENSIONS OF TIMBER PILES

SPECIES	LENGTH feet (m)	CLASS A PILES						CLASS B PILES		
		3' (1 m) from butt				at tip		3'. (1 m) from butt	at tip	
		CIRCUMFERENCE		DIAMETER		CIRC.	DIA.	DIAMETER	DIA.	
		MIN inches (mm)	MAX inches (mm)	MIN inches (mm)	MAX inches (mm)	MIN inches (mm)	MIN inches (mm)	MIN inches (mm)	MAX inches (mm)	MIN inches (mm)
DOUGLAS FIR, LARCH, AND PINE	under 20 (under 6)	32 (815)	63 (1600)	10 (255)	20 (510)	25 (635)	8 (205)			
	Under 40 (12)	38 (965)	63 (1600)	12 (305)	20 (510)	25 (635)	8 (205)	14 (360)	20 (510)	10 (255)
	40 to 50 incl. (12 to 14.9)	38 (965)	63 (1600)	12 (305)	20 (510)	22 (560)	7 (180)	14 (360)	20 (510)	9 (230)
	51 to 70 incl. (15 to 20.9)	41 (1045)	63 (1600)	13 (330)	20 (510)	22 (560)	7 (180)	14 (360)	20 (510)	8 (205)
	71 to 90 incl. (21 to 26.9)	41 (1045)	63 (1600)	13 (330)	20 (510)	19 (485)	6 (155)	14 (360)	20 (510)	7 (180)
	over 90 ^[1] (over 27) ^[1]									
OAK	under 30 (under 9)	41 (1045)	57 (1450)	12 (305)	18 (460)	25 (635)	8 (205)	14 (360)	18 (460)	10 (255)
	30 to 40 incl. (9 to 11.5)	41 (1045)	63 (1600)	13 (330)	20 (510)	22 (560)	7 (180)	14 (360)	20 (510)	9 (230)
	over 40 (over 12)	41 (1045)	63 (1600)	13 (330)	20 (510)	19 (485)	6 (155)	14 (360)	20 (510)	8 (205)

^[1] Dimensions of all timber piles over 90 feet (27 m) in length are as the plans or special provisions show.

508.2.2.5 Class C Piles

- (1) Use class C piles of adequate strength, shape, and dimensions suitable for the purpose intended. Ensure the piling is made of sound wood, free from defects that might impair its strength, in good condition, reasonably straight, and capable of withstanding driving.
- (2) There is no requirement to peel class C piles, but trim all limbs and knots flush with the surface.

508.2.2.6 Treated Piling

- (1) Treat timber piling with one of the following: a creosote-coal tar solution, a pentachlorophenol solution in petroleum solvent, a chromated copper arsenate solution, an ammoniacal copper arsenate solution, or an ammoniacal copper zinc arsenate solution. Apply the solution by the pressure process according to AASHTO M 133, except only treat oak with one of the following: creosote-coal tar, or pentachlorophenol in petroleum solvent. The contractor shall not treat Coastal and Interior Douglas Fir with chromated copper arsenate.
- (2) Unless the engineer directs otherwise, inspect the material before treatment. The engineer will accept material after treatment based on: its condition before treatment, inspection of the treatment procedure substantiated by plant records, the condition of the material after treatment, and on absorption, penetration borings, and visual inspection.
- (3) The department may re-inspect material after delivery and may reject any material that does not comply with specifications.

- (4) If possible, during treatment, sort the piles into groups of each species, and into pieces with approximately equal moisture and sapwood content, and sort to ensure the treating medium contacts all surfaces.

508.2.3 Coal Tar Treated Fabric

- (1) If using cotton fabric for waterproofing, conform to AASHTO M 117-88 for coal tar treated fabric.

508.3 Construction

508.3.1 Ordering Piling

- (1) If the contract contains the Piling Test Untreated Timber or Piling Test Treated Timber bid item, do not order the foundation or trestle piling until driving the timber test piling, as specified below, and the engineer determines from the data obtained the piling lengths to order.
- (2) If the contractor furnishes foundation or trestle piling in lengths other than those the engineer determines necessary, after driving the test piling, the department will not measure or pay for any of the unsatisfactory, unsuitable, or excess lengths of this piling. Do not plead misunderstanding of this requirement because engineer-determined lengths differ from the lengths the plans show.

508.3.2 Test Piling

- (1) Drive at least one treated or untreated test pile, as specified, conforming to class A piling and the length the plans show, for each substructure unit specified.
- (2) Instead of an untreated timber test pile, the contractor may furnish a treated test pile, with the engineer's approval.
- (3) The engineer will determine the location of each test pile for each specified substructure unit. Unless specified otherwise, drive the test piles at locations that allow their use in the finished structure.
- (4) Drive test piling under conditions similar to those prevailing for the foundation or trestle piling. Excavate the site of each test pile to the elevation of the bottom of the footing before driving test piles, and in the case of trestle bents, excavate each test pile site to the finished ground line elevation.
- (5) The engineer will determine the bearing and penetration to drive the test piles.
- (6) If incorporating into the structure as foundation or trestle piling, remove the test piling down to at least 2 feet (600 mm) below streambed or finished ground line.
- (7) The cutoff of a timber test pile is the department's property until all timber piling under the contract are driven.

508.3.3 Driving Equipment

508.3.3.1 General

- (1) Use equipment to drive test piling, foundation piling, or trestle piling conforming to the requirements specified below. Use gravity hammers only with the engineer's permission.
- (2) If required to pile drive to refusal, conform to the design bearing values the plans show for the size or energy rating of the hammer.

508.3.3.2 Gravity Hammers

- (1) At the engineer's request, the contractor shall furnish a certified scale weight for the gravity hammer proposing to use.
- (2) For driving piles to required bearing values up to 35 tons (314 kN) per pile use a gravity hammer weighing at least 3000 pounds (1360 kg). For driving piles to required bearing values up to 50 tons (445 kN) per pile use a gravity hammer weighing at least 4000 pounds (1815 kg). And, for driving piles to required bearing values over 50 tons (445 kN) per pile use a gravity hammer weighing at least 5000 pounds (2270 kg).
- (3) Regulate the fall of a gravity hammer to avoid injuring the pile, preferably not to exceed 10 feet (3 m) and in no case exceed 15 feet (4.6 m).
- (4) Mount the load line on a free drum.

508.3.3.3 Air, Steam, or Diesel Hammers

- (1) If the engineer requests, the contractor shall furnish authentic data for the hammer the contractor proposes to use as follows:
 - For air or steam hammers, furnish the ram weight, the ram stroke, the hammer's rated energy in foot-pounds (joules) per blow, and the number of blows per minute at the rated energy.
 - For diesel hammers, furnish the ram weight, the hammer's maximum rated energy in foot-pounds (joules) per blow, and the normal number of operating blows per minute.
- (2) The hammer's energy rating in foot-pounds (joules) per blow of shall at least equal E in the following formula, except that the minimum rated energy shall equal 7200 foot-pounds (9760 joules) per blow:

$$E = 0.15 (45.72) P$$

Where:

E = Hammer energy rating, in foot-pounds (joules) per blow

P = Required bearing of pile, in pounds (kN).

- (3) Reduce the maximum energy rating the manufacturer furnishes for diesel hammers by 25 percent in order to comply with the above formula.
- (4) If driving to required bearing, operate the hammer at the rate of blows per minute, or within the range of the rate, according to the manufacturer's recommendation.

508.3.3.4 Leads

- (1) All hammers require leads. In general, construct pile driver leads to give the hammer freedom of movement, and hold them in position by guys or stiff braces to ensure pile support during driving.
- (2) Rig the swinging leads to maintain the hammer's travel in line with the axis of the pile and to give adequate support to drive the pile within the accuracy tolerance specified.
- (3) Piles not driven within the specified accuracy tolerance are subject to removal and replacement at the no expense to the department.
- (4) Use inclined leads to drive batter piles.
- (5) Except if driving piles through water, make the leads long enough to not require a follower.

508.3.3.5 Followers

- (1) Use followers only if driving piles through water and only with the engineer's permission. If using followers, make one pile from each group of 10 a pile long enough to drive without a follower and use it to determine the average bearing capacity of the group. The contractor shall furnish this pile's extra length over the normal ordered length at no expense to the department. The contractor may drive piles through water with engineer-approved underwater driving hammers instead of furnishing extra length piling.

508.3.3.6 Water Jets

- (1) If using water jets, ensure a sufficient number of jets, and a volume and pressure of water at the jet nozzle to freely erode the material next to the pile. Ensure a plant capacity capable of operating 2 jet nozzles simultaneously with at least 100 pounds per square inch (690 kPa) pressure each. Before reaching the final penetration withdraw the jets and drive the piles with the hammer to secure the final penetration and bearing.
- (2) Do not use water jets while driving piling through roadway embankments.

508.3.3.7 Caps

- (1) If necessary to protect the pile against damage during driving, equip the top of the pile with a driving cap of a size and type that serves the purpose. Use a shock block of engineer-approved type and size on the upper side of the driving cap, if necessary. Generally, follow the pile hammer manufacturer's recommendations with respect to driving caps and shock blocks.

508.3.3.8 Collars

- (1) Provide collars or bands to protect piles against splitting or brooming if necessary.

508.3.4 Storing and Handling

- (1) Store and handle the piles in a manner that avoids injury to the piles. Take care not to break the surface of treated piles. Do not use chains, cant hooks, dogs, pike poles, or other pointed tools. Carefully trim cuts or breaks in the surface of treated piling and then cover with 3 applications of a compatible preservative material. Use a preservative and application method conforming to AWWA Standard M4. Apply each succeeding application at least 2 hours after the previous.
- (2) Fill bolt holes with a compatible preservative material.

508.3.5 Driving

508.3.5.1 General

- (1) Unless specified otherwise, drive piling with a gravity hammer if allowed, single-acting hammer (air or steam), double-acting hammer (air or steam), differential-acting hammer (air or steam), diesel hammer, or with a combination of water jet and hammer.
- (2) Coordinate the pile driving and concrete placement operations so that no damage or displacement occurs to concrete in any substructure unit because of pile driving operations in any other unit.
- (3) Do not drive foundation or trestle piles for a substructure unit until the excavation for them is complete. Remove any material forced up within the limits of the footing to correct elevation before placing masonry in that footing, the contractor shall remove this material at no expense to the department.
- (4) Drive piles without varying more than 1/4 inch per foot (6 mm per 300 mm) from the vertical or from the batter the plans show, except drive piles for trestle bents so that placing the cap on the piles does not induce excessive stress. Ensure that foundation piles are within 6 inches (150 mm) of the position the plans show after driving.
- (5) Taper pile tips to a point not less than 4 inches (100 mm) square.
- (6) Drive piles so that the cutoff is at least 8 inches (200 mm).
- (7) Do not use followers to drive piling except as specified for piling driven through water.
- (8) Do not splice foundation and trestle piling.
- (9) If driving adjacent piles causes foundation or trestle piles to rise, drive them down again if the engineer requires.
- (10) Correct all damaged or misplaced piles, at no expense to the department, either by removing and replacing the pile, or by driving a second pile adjacent to the damaged or misplaced pile, as the engineer approves.
- (11) Drive piles continuously to the required bearing, unless the engineer approves discontinuous driving. The engineer may review discontinuous driving at the end of the initial driving. Perform subsequent driving as the engineer directs. For the purposes of this subsection, consider discontinuous driving as an interruption to driving a pile that lasts 3 hours or more.
- (12) Drive piles in a cluster circumferentially, starting at the inside of the cluster and proceeding toward the outside.

508.3.5.2 Bearing Value

- (1) Drive piles to a bearing value not less than that the plans show with hammers conforming to [508.3.3](#).
- (2) Compute theoretical bearing values according to the following formulae:

$$P = 2WH/(S + 0.5) \text{ for gravity hammers}$$

$$P = 2E/(S+0.2) \text{ for air, steam, or diesel hammers}$$

Where:

P = Safe bearing value in pounds.

W = Weight of ram or striking parts of hammer in pounds.

H = Height of fall of ram or striking parts of hammer in feet.

S = The average penetration in inches per blow for the last 5 to 10 blows for gravity hammers and the last 10 to 20 blows for air, steam or diesel hammers.

E = Energy in foot-pounds per blow.

P = $(FH)/[6(S + 12.7)]$ for gravity hammers

P = $E/[6(S+5.08)]$ for air, steam, or diesel hammers

Where:

P = Safe bearing value in kilonewtons.

F = Force of ram or striking parts of hammer in kilonewtons.

H = Height of fall of ram or striking parts of hammer in millimeters.

S = The average penetration in millimeters per blow for the last 5 to 10 blows for gravity hammers and the last 10 to 20 blows for air, steam or diesel hammers.

E = Energy in joules per blow.

Where:

- For Single-acting air or steam hammers, $E = WH$.
- For double-acting or differential-acting air or steam hammers, E equals the hammer manufacturers rated energy per blow operating at the designated number of blows per minute.
- For diesel hammers with unrestricted ram rebound, $E = WH$. Use hammers with an attached gauge for measuring H .
- For diesel hammers with an enclosed ram, E equals the average equivalent energy in foot-pounds (joules) taken from the gauge attached to the hammer and recorded during the period when the average penetration per blow is recorded. Provide these hammers with a gauge and applicable charts to evaluate the equivalent energy produced under any driving condition.

(3) The above formulae are applicable only if:

1. The gravity hammer has a free fall.
2. The head of the pile is not broomed or crushed.
3. The penetration is reasonably quick and uniform.
4. No follower is used.
5. There is no noticeable bounce after the blow. If there is a noticeable bounce, deduct twice the height of the bounce from H to determine its value in the above formulae.

(4) Consider the bearing values of piles determined by the above formulae effective only if they are less than the crushing strengths of the piles. Take into consideration: the character of the soil penetrated; driving conditions; the distribution, sizes, and lengths of the piles involved; and the computed load per pile during determination of the reliability of driven piles.

(5) If using water jets in connection with the driving, determine the bearing value by the above formulae from the results of driving after withdrawing the jets.

508.3.5.3 Penetration

(1) For foundation piling, drive piles at least 10 feet (3 m) below the streambed elevation or original ground if using pile bents, or at least 10 feet (3 m) below the bottom of footings or original ground elevation, whichever is lower, unless the plans specify otherwise or the engineer specifically allows in writing. The engineer may require preboring to achieve minimum penetration.

508.3.5.4 Cutting Off Piles

(1) After completing foundation or trestle pile driving for a substructure unit, saw the tops off all pilings in the unit true to the plane the plans show. Apply one coat of a compatible preservative treatment to the resulting preliminary sawed surface, and 3 coats to the resulting final cutoff sawed surface. Use a preservative and application method conforming to AWPAS Standard M4. Allow at least 2 hours between applications.

(2) All pile cutoffs, except lengths the contractor orders to facilitate the work and the extra lengths required if using followers are department property. They shall remain department property until all timber piling under the contract is driven.

508.3.5.5 Prebored Holes

- (1) If the plans or contract special provisions require prebored holes, make them the length or depth the plans show. Unless directed otherwise, make the diameter of the hole approximately the same as the diameter of the pile. If boring holes through roadway embankments that exceed the diameter of the piling, backfill them with sand after driving the piling.

508.3.6 Piling for Trestle Bents

- (1) In addition to the general requirements for timber piling, conform to the following requirements for piling for trestle bents:
- (2) Carefully, select the size of the piles for each bent to avoid any undue bending or distortion of the sway bracing without cutting the piles.
- (3) Drive the piles as accurately as possible, in the correct location, and to the vertical lines or batter, the plans show. If a pile is driven out of line, straighten it without injury before cutting off or bracing. Remove and replace all piles damaged in straightening at no expense to the department. Do not shim the tops of piles.
- (4) Use suitable clamps on treated piles to support staging or other construction facilities, and under no circumstances bolt, spike, or nail construction facilities to treated piling.
- (5) Place a piece of sheet zinc, of the dimensions and thickness the plans show, on the top of each pile that receives a cap. Before placing the zinc, treat the top of the piling as specified for cut surfaces in [508.3.4](#).
- (6) Coat the tops of treated piles in wings with alternate layers of hot coal-tar pitch, conforming to [507.2.4](#), and coal-tar treated fabric, conforming to [508.2.3](#), using 4 applications of pitch and 3 layers of fabric. Make the fabric cover at least 6 inches (150 mm) larger in dimension than the diameter of the pile and neatly fold down over the pile, secure in place with zinc coated wire and large-headed zinc coated nails. Place at least 7 wrappings of wire around the piling, over the fabric. Draw the wire tight and secure with zinc coated nails or staples. Neatly trim the edges of fabric to line below the wire. Apply the pitch to the piling beneath the turned down wrapping as well as to the top and completely mop the entire fabric.
- (7) Fill holes bored in treated piling with a compatible preservative treatment.
- (8) Insert a tight-fitting treated plug into all holes not used for bolts, rods, etc.

508.3.7 Salvaged Pile Cutoffs

- (1) During the progress of construction and before ordering the piling for a unit, the engineer may order the contractor to furnish any or all piling for the unit by driving suitable salvaged cutoffs accumulated under the contract.
- (2) After driving all the timber piling under the contract, all cutoffs not salvaged and used in the work become the contractor's property for disposal.

508.4 Measurement

508.4.1 Timber Test Piling

- (1) The department will measure the Piling Test bid items as a single lump sum unit for each structure acceptably completed. Each unit measured equals the number and length of untreated timber test piling the plans show for the structure.

508.4.2 Timber Piling Delivered

- (1) The department will measure Piling Untreated Timber Delivered and Piling Treated Timber Delivered by the linear foot acceptably completed. The measured quantity equals the sum of the nominal lengths of piling the engineer ordered based on test piling driven. The department will not measure for payment additional lengths the contractor ordered to facilitate the work. The department will not measure test piles incorporated in the finished work as foundation or trestle piling.
- (2) If piling are driven through water and one pile in each group of 10 is required to be extra long for determining the group bearing capacity, the department will not measure the extra length of this pile over the nominal ordered length for the group.

508.4.3 Timber Piling Driven

- (1) The department will measure Piling Untreated Timber Driven and Piling Treated Timber Driven by the linear foot acceptably completed. The department will not measure test piles incorporated in the finished work as foundation or trestle piling.

- (2) For foundation or bearing piling the quantity measured equals the sum of the lengths left in place below cutoff.
- (3) For piling for trestle bents, shear booms, and pile clusters, the quantity measured equals the sum of the lengths left in place below the ground surface as it existed before driving started. For timber abutments, consider the ground surface to be the bottom of excavation for timber backing. For trestle bents, consider the ground surface to be the existing or constructed streambed.

508.4.5 Preboring Timber Piling

- (1) The department will measure Preboring Timber Piling by the linear foot acceptably completed. The department will not measure holes for test piling separately.

508.5 Payment

508.5.1 General

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
508.0100	Piling Test Untreated Timber (structure)	LS
508.1000	Piling Untreated Timber Delivered	LF
508.1300	Piling Untreated Timber Driven	LF
508.1600	Piling Treated Timber Delivered	LF
508.2000	Piling Treated Timber Driven	LF
508.3000	Piling Test Treated Timber (structure)	LS
508.4000	Preboring Timber Piling	LF

- (2) If, under [508.3.1](#), the contractor furnishes piling of a different length than engineer determines necessary, the department will not pay for any of the unsatisfactory, unsuitable, or excess lengths of this piling.
- (3) The department will not make any additional payment for treated piles substituted for untreated piles as allowed under [508.3.2](#).
- (4) The department will not pay for piling from salvaged cutoffs, as allowed under [508.3.5](#), except for preparing and pointing the pile for driving as specified under [508.5.2](#).
- (5) If the engineer requires preboring, but the contract does not contain the Preboring Timber Piling bid item, the department will pay for preboring as extra work.

508.5.2 Timber Test Piling

- (1) Payment for the Piling Test Untreated Timber bid items and the Piling Test Treated Timber bid items is full compensation for, treating if required, all excavating necessary to drive test piling not included within the limits of the Excavation for Structures bid items; for providing and driving the test piling; for removing any test piling not incorporated in the finished structure; for cutting off the test piling that is incorporated; and for disposing of the removed piles or pile cutoffs, regardless of length, not salvaged and used in the work.

508.5.3 Timber Piling Delivered

- (1) Payment for Piling Untreated Timber Delivered and Piling Treated Timber Delivered is full compensation for providing, treating if required, and delivering acceptable piling.
- (2) The department will pay for preparing and pointing of salvaged pile cutoffs, that the engineer designates for use as piling, at a price per piling prepared and pointed. The department will determine this price by multiplying the contract unit price for Piling Untreated Timber Delivered and Piling Treated Timber Delivered by 5 for US standard measure projects (2 for SI metric projects). The department will pay for preparing and pointing under the Preparing and Pointing Salvaged Timber Pile Cutoffs administrative item. Payment for preparing and pointing salvaged pile cutoffs is full compensation for providing all labor, tools, equipment, and incidentals necessary to prepare the salvaged pile cutoff for driving.

508.5.4 Timber Piling Driven

- (1) Payment for Piling Untreated Timber Driven and Piling Treated Timber Driven is full compensation for preparing, framing, driving and cutting off piling; for disposing of pile cutoffs not salvaged and used in the work; for treating cuts and abrasions; and for removing and disposing of upheaved material.

508.5.5 Preboring Timber Piling

- (1) Payment for Preboring Timber Piling is full compensation for boring; for providing and placing necessary backfill material; and for disposing all material excavated by boring.

SECTION 509 CONCRETE OVERLAY AND STRUCTURE REPAIR

509.1 Description

- (1) This section describes cleaning or scarifying areas of decks and approach pavements to be overlaid; removing and disposing any remaining asphaltic patches or unsound concrete from those areas; the furnishing, placing and curing concrete overlays; and full depth deck, surface, curb and joint repairs, as required.

509.2 Materials

- (1) Furnish a neat cement bonding grout. Mix the neat cement in a water-cement ratio approximately equal to 5 gallons (19 L) of water per 94 pounds (42.7 kg) of cement
- (2) Furnish concrete for the Concrete Masonry Overlay bid items conforming to grade E concrete, [section 501](#).
- (3) Furnish concrete for the Concrete Surface Repair bid item conforming to grade C, C-FA, C-S, C-IS, C-IP or E concrete, [section 501](#), except the contractor may increase the slump for grade E concrete to a maximum of 4 inches (100 mm). The contractor may apply an engineer-approved commercial grout or surface coating to surfaces being repaired instead of the grades of concrete designated above if it is impractical to apply that masonry, if the engineer specifically approves in writing.
- (4) Furnish concrete for Joint Repair, Curb Repair, and Full-Depth Deck Repair conforming to grade C, C-FA, C-S, C-IS, C-IP, D, or E concrete as specified in [section 501](#); except as follows:
 1. The contractor may increase slump of grade E concrete to 3 inches (75 mm).
 2. The contractor may use ready-mixed concrete.

509.3 Construction

509.3.1 Equipment

- (1) Use a finishing machine to finish concrete overlays conforming to [502.3.7.8](#) the following:
 1. The machine shall have 2 linearly oscillating transverse screeds. For the front screed use, a synchronous vibratory screed with a variable frequency the operator can adjust. Provide a sufficient number of identical vibrators so there are at least 2 vibrators for each 5 feet (1.5 m) of screed length. Ensure that the bottom face of each screed is at least 7 inches (175 mm) wide with a rounded leading edge. Each screed shall have an effective weight of at least 75 pounds per square foot (366 kg/m²) of bottom face area. Provide each screed with the capability to positively control of the vertical position, the angle of tilt and the shape of the crown.
 2. The machine shall have an adjustable metering device ahead of the leading screed that traverses the width of the machine.
 3. The machine shall have capability of forward and reverse motion under positive control. Make provisions for raising the screeds to clear the screeded surface for traveling in reverse.
- (2) If placing concrete in a line next to a previously completed lane, equip the side of the finishing machine next to the completed lane, to travel on the lane.

509.3.2 Cleaning

- (1) Under the Cleaning Decks and Cleaning Approaches bid items, clean the decks and approach pavements before placing the concrete overlay.
- (2) Use construction methods conforming to [section 502](#) and the following:
 1. Clean the entire surface of the bridge deck or approach pavement receiving the new concrete by using a suitable mechanical scarifier. Accomplish this in a manner that prevents hooking or tearing the reinforcing steel and that removes at least one inch (25 mm) of concrete from the deck or pavement surface but not more than the maximum depth the plans show.
 2. If scarification is impracticable, as along curb faces or at expansion joints, remove deteriorated concrete to sound material by using chippers conforming to [509.3.3](#) for chippers.
 3. Perform scarification before preparation. After completing scarification, remove the remaining asphaltic patches and unsound concrete as specified for preparation in [509.3.3](#).
 4. Blast clean the entire surface of the deck and approach pavements being overlaid, all exposed reinforcing steel, the vertical faces of curbs, sidewalks and parapets to the depth of the adjoining concrete overlay after completing preparation.

5. Clean the surface receiving the new concrete by brooming and water pressure using a high-pressure nozzle to remove all loose particles and dust, or water and air pressure. Use water for cleaning conforming to specifications for water under [501.2.4](#)

509.3.3 Preparation

- (1) Under the Preparation Decks and Preparation Approaches bid items, remove all asphaltic patches and unsound or disintegrated areas of concrete decks and approach pavements as the plans show, or as the engineer directs.
- (2) Use construction methods conforming to [section 203](#) and the following:
 1. Under the Preparation Decks Type 1 bid item, remove existing asphaltic patching and unsound bridge deck concrete only to a depth that exposes 1/2 of the peripheral area of the top or bottom bar steel in the top mat of reinforcement.
 2. Under the Preparation Decks Type 2 bid item, remove existing unsound bridge deck concrete below the limit of the type 1 removal described above. One inch (25 mm) below the bottom of the top or bottom bar steel in the top mat of reinforcement is the minimum depth of type 2 removal. The engineer will direct any further removal.
 3. Remove the existing asphaltic patching and unsound concrete using equipment that causes no damage to the bridge floor. If chipping exposes the existing bar steel reinforcement for more than 1/2 of its peripheral area, and where bond between existing concrete and reinforcing bar has been destroyed, remove the adjacent concrete to provide a minimum one-inch (25 mm) clearance around the bar.
 4. For chipping off the old concrete surface, use air chippers or breakers that weigh no more than 35 pounds (16 kg) and are equipped with flat, chisel-type points with a cutting edge not less than 3/4 inch (19 mm) or greater than 3 inches (75 mm) wide.
 5. If the engineer allows, the contractor may use chippers or breakers weighing more than 35 pounds (16 kg) but not more than 60 pounds (27 kg) and equipped with a 3-inch (75 mm) chisel-type point instead of the 35-pound (16 kg) chipper. Discontinue use if damage to steel or concrete designated to remain results.
 6. For removals below the top of and within one inch (25 mm) of the reinforcing steel, do not use hammers heavier than 15 pounds (7 kg).
 7. Dispose of all old concrete and asphaltic patching removed away from the bridge site. Implement necessary procedures to minimize debris dropping into the stream, streambed, roadway, or right-of-way below.

509.3.4 Joint Repair

- (1) Under the Joint Repair bid item, remove and dispose of deteriorated concrete at existing joints over piers, abutments and deck ends and other locations, and form new joints as the plans show, and the engineer directs.
- (2) Use construction methods conforming to [section 203](#), [section 502](#), and the following:
 1. Remove the concrete at an existing joint to be replaced to the limits the plans show, or as the engineer directs. Place a 1/2 inch (13 mm) deep saw cut at the line of removal on the bottom edge of the deck to control concrete breakout or cover the line of removal with a 1 1/2 inch (38 mm) thick layer of concrete to cover all reinforcing steel exposed during joint repair. Use removal equipment that causes no damage to the portion of the concrete floor, curbs, and reinforcing steel remaining in place. Do not use tractor-mounted rams for removal operations within 9 inches (225 mm) of the edge, or within the depth of the slab from the edge, whichever is less.
 2. The contractor shall preserve and utilize the required existing reinforcing steel, and blast clean, realign, and retie, as the engineer considers necessary. Additional required reinforcing steel shall conform to [505.2.3](#).
 3. Dispose of removed material as specified in [509.3.3](#).
 4. Clean the surface receiving the new concrete by brooming and water pressure using a high-pressure nozzle to remove all loose particles and dust.
 5. Immediately before placing concrete, coat the surfaces of the old concrete receiving new concrete with neat cement as specified for concrete overlays in [509.3.8.2](#).
 6. Restore painted surfaces damaged by any construction operation to the satisfaction of the engineer.
 7. Place concrete as specified for joint repair in [509.3.8.1](#).

509.3.5 Curb Repair

- (1) Under the Curb Repair bid item, remove and dispose of portions of deteriorated concrete on the concrete curbs and form new curb faces, top or back as the plans show.

- (2) Use construction methods conforming to sections 203, [section 502](#), and the following:
1. Take the precautions necessary while removing deteriorated concrete to preserve all existing reinforcing steel. Clean, realign, and retie existing reinforcing steel, as the engineer considers necessary.
 2. Remove concrete to sound concrete or at least one inch (25 mm) behind existing reinforcing steel as the plans show and the engineer directs.
 3. Make a 1/2-inch (13 mm) deep saw cut at the limits of curb repair before removing the deteriorated concrete.
 4. Dispose of removed material as specified in [509.3.3](#).
 5. Clean the surface against which placing the new concrete to remove all loose particles and dust, and keep continuously wet for 2 hours before placing new concrete. Immediately before placing concrete, coat the surfaces of old concrete with neat cement as specified in [509.3.8.2](#).
 6. Place concrete as specified in [509.3.8.1](#).

509.3.6 Concrete Surface Repair

- (1) Under the Concrete Surface Repair bid item, remove those portions of abutments, piers, girders, and other elements that the plans show, and the engineer directs, and replace those portions with concrete.
- (2) Use construction methods conforming to [section 203](#), [section 502](#), and the following:
1. Take necessary precautions while removing deteriorated concrete to preserve all existing reinforcing steel. Clean, realign and retie existing reinforcing steel, as the engineer considers necessary.
 2. Remove concrete to sound concrete or to one inch (25 mm) behind the existing reinforcing steel, whichever depth is greater, at locations the plans show or as the engineer directs.
 3. Make a 1/2-inch (13 mm) deep saw cut at the limits of the concrete surface repair before removal of the deteriorated concrete.
 4. Dispose of removed material as specified in [509.3.3](#).
 5. Clean the surfaces against which placing the new concrete to remove all loose particles and dust, and keep continuously wet for a period of 2 hours before placing new concrete.

509.3.7 Full Depth Deck Repair

- (1) Under the Full-Depth Deck Repair bid item, perform full-depth removal of unsound concrete at locations on the deck as the engineer directs, and then prepare and form these areas.
- (2) Use construction methods conforming to [section 203](#), [section 502](#), and the following:
1. Completely remove the existing concrete deck areas being repaired using equipment that causes no damage to that portion of the concrete floor, curbs, bar steel reinforcing, and concrete girders that are remaining in place. The contractor shall preserve and utilize the required existing reinforcing steel.
 2. If damage occurs to anything designated for re-use in the new work repair, or replace it at no expense to the department.
 3. Dispose of removed material as specified in [509.3.3](#).
 4. Blast clean, realign, and retie the existing reinforcing steel to be re-used, as the engineer considers necessary.
 5. Clean the vertical surface receiving the new concrete by brooming and water pressure to remove all loose particles and dust, and keep continuously wet for 2 hours before placing concrete. Immediately before placing concrete in the full depth deck replacement, coat the entire surface receiving the new concrete with neat cement as specified in [509.3.8.2](#).
 6. Place the concrete for the repair as specified in [509.3.8.1](#).

509.3.8 Concrete

509.3.8.1 General

- (1) Under the Concrete Masonry Overlay Decks and Concrete Masonry Overlay Approaches bid items, construct a concrete overlay course on concrete deck and approach pavement to the lines, grades, thickness, and cross section the plans show, or the engineer directs.
- (2) Use construction methods conforming to [section 502](#) and the following:
1. For joint repair, place the concrete and consolidate by vibrating in the prepared joints before placing the overlay.

2. For curb repair, place the concrete, consolidate, and strike off to the required alignment for curb faces, tops, and backs.
3. For full depth deck repair, place the concrete; consolidate by internal vibration, and strike off to the existing deck elevation before placing the overlay.

509.3.8.2 Placing Concrete Overlays

- (1) Immediately before placing the concrete overlay, coat the surface of the bridge decks or approach pavement being overlaid, and all vertical joints with a neat cement mixture. Ensure the surface of the existing deck is completely dry for at least 1/2 hour before coating with the neat cement mixture. Brush the neat cement over the prepared concrete surface to ensure all parts receive an even coating and do not allow excess neat cement to collect in pockets. Apply the neat cement at a rate that ensures the cement does not dry out before covering with the new concrete.
- (2) Place concrete for deck preparation immediately in front of the overlay course and vibrate internally in addition to surface screed vibration. Place concrete in a single operation, with no construction joints in the overlay section except as the plan show or the engineer directs. Do not place concrete if the ambient air temperature is above 88 F (31 C).
- (3) The contractor may operate the finishing machine with the transverse screeds normal to the centerline of the structure. Conduct bridge deck finishing operations so that the elapsed time between depositing the concrete on the deck and final screeding does not exceed 10 minutes.
- (4) If the plan requires construction joints, make them sharp-edged, perpendicular to the overlay surface, at the locations the plan show, and true to the alignments the plan show.
- (5) Provide the final surface finish specified in [502.3.7.8](#) for floors of structures having approach pavements with design speeds of 40 mph (65 km/h) or greater, except there is no requirement for the turf drag or broom finish.
- (6) Form or saw contraction joints to the width, depth, and at locations the plans show and seal as the plans show. Begin sawing joints within 6 hours after placing the concrete, unless the engineer directs otherwise, and complete within 12 hours.

509.3.8.3 Curing Concrete Overlays

- (1) Cure concrete overlays as specified for curing concrete in floors, wearing surfaces, and sidewalks in [502.3.8](#), including fogging, and allow to cure for 3 days.

509.3.8.4 Opening to Traffic

- (1) Do not allow traffic on the completed overlay for a minimum of 3 days after placement. The engineer may extend this time if conditions warrant.

509.4 Measurement

- (1) The department will measure Preparation Approaches and the Preparation Decks bid items by the square yard acceptably completed. The department will not subtract areas of type 2 removal from areas of type 1 removal. The department will subtract areas of full-depth deck repair, directed by the engineer before beginning the type 1 or type 2 deck removals, from the areas of the type 1 or type 2 removals. The department will not subtract areas of full-depth deck repair, directed by the engineer after type 1 or type 2 deck removals are underway, from the areas of the type 1 or type 2 removals. The department will not measure areas of joint repair under these bid items.
- (2) The department will measure Cleaning Decks, Cleaning Approaches, Joint Repair, and Full-Depth Deck Repair by the square yard acceptably completed.
- (3) The department will measure Curb Repair by the linear foot acceptably completed.
- (4) The department will measure Concrete Surface Repair by the square foot acceptably completed, measured as the exposed surface area, following removal, as delineated by the saw cuts.
- (5) The department will measure the Concrete Masonry Overlay bid items by the cubic yard acceptably completed. The department will measure concrete used in joint repair, curb repair, and in full-depth deck repair as part of the Concrete Masonry Overlay bid items. The department compute yardage based on the nominal cubic yard of concrete defined in [501.3.2.2](#). The department will not measure wasted concrete.

509.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
509.0200	Preparation Approaches	SY
509.0300 - 0399	Preparation Decks (type)	SY
509.0500	Cleaning Decks	SY
509.0600	Cleaning Approaches	SY
509.1000	Joint Repair	SY
509.1200	Curb Repair	LF
509.1500	Concrete Surface Repair	SF
509.2000	Full-Depth Deck Repair	SY
509.2500	Concrete Masonry Overlay Decks	CY
509.2600	Concrete Masonry Overlay Approaches	CY

509.5.1 Preparation

- (1) Payment for Preparation Approaches and the Preparation Decks bid items is full compensation for removing asphaltic patches and unsound concrete; and for disposing of waste materials.

509.5.2 Cleaning

- (1) Payment for Cleaning Decks and Cleaning Approaches is full compensation for scarifying, and cleaning the deck or approaches; and for blast cleaning the entire deck or approaches, including all exposed existing reinforcing steel.

509.5.3 Joint Repair

- (1) Payment for Joint Repair is full compensation for removing and disposing of deteriorated concrete, and for forming new joints.
- (2) The department will pay for concrete used under the Concrete Masonry Overlay bid items.
- (3) The department will not pay for restoration of painted surfaces damaged by construction operations.

509.5.4 Curb Repair

- (1) Payment for Curb Repair is full compensation for removing and disposing of deteriorated concrete; for forming; and for disposing of waste material.
- (2) The department will pay for concrete used under the Concrete Masonry Overlay Decks bid item.

509.5.5 Concrete Surface Repair

- (1) Payment for Concrete Surface Repair is full compensation for removing and disposing of deteriorated concrete; and for cleaning reinforcing steel; for forming, furnishing, hauling, placing, curing, and protecting all materials.

509.5.6 Full Depth Deck Repair

- (1) Payment for Full-Depth Deck Repair is full compensation for completely removing the deteriorated concrete areas; for disposing of waste material; for forming; and for salvaging and using the existing bar steel reinforcement. The department will pay for this bid item at the contract unit price regardless of whether the engineer directs it before or after beginning the type 1 or type 2 removals.
- (2) The department will pay for concrete used under the Concrete Masonry Overlay Decks bid item.

509.5.7 Concrete Overlays

- (1) Payment for the Concrete Masonry Overlay bid items is full compensation for providing, hauling, preparing, placing, finishing, curing and protecting concrete; and for sawing and sealing joints, if applicable, unless specified otherwise.

SECTION 510 CAST IN PLACE CONCRETE PILING

510.1 Description

- (1) This section describes furnishing, driving, pre boring if required, splicing if necessary, cutting off and painting if necessary, metal piling shells; furnishing, placing, curing and protecting the concrete cores within the shells; and placing the bar steel reinforcement in the top of the cast in place concrete trestle piling or cast in place concrete foundation piling.

510.2 Materials

510.2.1 General

- (1) Furnish materials conforming to the following:
 - Concrete [section 501](#)
 - Steel reinforcement..... [section 505](#)
- (2) Construct the concrete cores using grade A, A-FA, A-S, A-T, A-IS, or A-IP conforming to [501.2](#).

510.2.2 Steel Pile Shells

510.2.2.1 General

- (1) Ensure that the steel pile have the outside diameter at the butt the plans show. Ensure they are cylindrical or tapered; are the spiral welded, straight-seam welded, or the seamless tube type and have a minimum nominal shell thickness of 0.219 inches (5.56 mm); or are fluted steel shells having a minimum shell thickness of at least 0.179 inches (4.55 mm), unless the plans show otherwise, or the special provisions specify otherwise.
- (2) All pile shells shall have sufficient strength and rigidity to withstand driving to the required penetration and bearing. Unless the plans show or the contract specifies otherwise, equip all pile shells with engineer-approved conical driving points or attached plate ends.
- (3) Plates shall have a minimum thickness of 3/4 inch (19 mm) unless the plans show otherwise, and the plate diameter shall not exceed the outside diameter of the piles by more than 3/4 inch (19 mm).
- (4) Use only one type of pile throughout a structure unless the engineer allows otherwise.
- (5) Paint the portion of the steel pile shells exposed in the completed work according to [511.3.5](#).

510.2.2.2 Material Requirements

510.2.2.2.1 Cylindrical Type

- (1) Make the pile shells from steel conforming to ASTM A 252, grade 2, or an engineer-approved alternate.

510.2.2.2.2 Tapered, Fluted Type

- (1) The material in the pile shell shall conform to SAE Steel Specifications and have the following chemical ranges and limits:

CONSTITUENT	PERCENT
Carbon.....	0.08-0.13
Manganese.....	0.30-0.60
Sulfur	0.05 maximum
Phosphorus	0.04 maximum

- (2) The minimum tensile yield strength of the steel in the fabricated pile shall equal 50 000 pounds per square inch (344.8 MPa).

510.2.2.3 Sampling and Testing

- (1) Unless the contract requires otherwise, the contractor shall submit to the engineer at the time of pile shells delivery a manufacturer's certified report of test or analysis showing the pile shells conform to the above requirements. The delivered shells shall bear markings identifying them with the applicable test report or, in the absence of this identification; certify that the delivered shells are from the same lot the test report represents.

510.3 Construction

510.3.1 Ordering Pile Shells

- (1) The estimated lengths of piling the plans show are approximate only and were determined for design and estimating purposes from a few soil soundings taken at the site. The contractor shall furnish cast in place piles of sufficient lengths to obtain the required penetration and specified bearing for each pile.

510.3.2 Shell Lengths and Splices

- (1) Unless the contract requires otherwise, and except for piling made, with the engineer's permission, from cutoffs, furnish all steel shells for cast in place concrete piling up to 50 feet (15 m) in length with not more than 3 shop or field welded splices. Furnish pile shells over 50 feet (15 m) in length with not more than 4 shop or field welded splices.
- (2) Weld all splices in piles as specified for welding in [506.3.19.1](#) and as the plans show. Perform all welding using skilled welders conforming to [506.3.19.1](#).

510.3.3 Equipment for Driving

- (1) Use equipment to drive metal shells for trestle piling or foundation piling conforming to the equipment requirements in [508.3.3](#).

510.3.4 Driving

510.3.4.1 General

- (1) Except as specified otherwise, use the following to drive the piling: a gravity hammer, if allowed; single-acting hammer (air or steam); double-acting hammer (air or steam); differential-acting hammer (air or steam); diesel hammer; or with a combination of water jet and hammer.
- (2) Drive the pile shells with a variation of not more than 1/4 inch per foot (6 mm per 300 mm) from the vertical or from the batter the plans show. Except, drive the piles for trestle bents so placing the cap in its proper location does not induce excessive stress in the piles and the piles in each row appear aligned. Ensure the foundation piles are within 6 inches (150 mm) of the position the plans show after driving.
- (3) Do not drive any metal pile shells for a substructure unit until completing the excavation for that unit.
- (4) Coordinate the pile driving and concrete placement operations so that no damage or displacement to concrete occurs in any substructure unit because of pile driving operations in any other unit.
- (5) Drive down all foundation or trestle piles raised by the driving of adjacent piles if the engineer directs.
- (6) Perform pile driving continuously to the required bearing, unless the engineer approves discontinuous driving. The engineer may review discontinuous driving at the end of the initial driving. Perform subsequent driving as the engineer directs. For the purposes of this subsection, define discontinuous driving as an interruption to the driving of a pile lasting 3 hours or more.
- (7) Drive piles in a cluster circumferentially, starting at the inside of the cluster and proceeding toward the outside.
- (8) Protect the top of the metal pile shell being driven from damage by using a suitable driving head.
- (9) After driving, keep the shells watertight until placing concrete in the shell.
- (10) Remove and replace all shells that suffer breaks, bends, or kinks that result from handling or driving, or are damaged due to internal defects and that in the engineer's judgment are unsuitable for use, at no expense to the department. Instead of removing and replacing, at the engineer's option the contractor may drive a second pile adjacent to the damaged pile, if this can be done without detriment to the structure.
- (11) Make available a suitable light for inspecting the entire interior of the driven shell before placing concrete in the shell.
- (12) If possible drive all pile shells required for a given substructure unit before placing concrete in any of the shells in the unit. Do not drive pile shells within a 15-foot (5 m) radius of any concrete filled pile shell, until the concrete cures for at least 7 days, or 3 days if using high early strength concrete. Except that if using grade A-FA, A-S, A-T, A-IS, or A-IP concrete in the work, and field operations are not controlled by cylinder tests, then increase the time to 14 days. If controlling field operations by cylinder tests, proceed driving the pile shells as described, with the engineer's approval, if cylinder tests show a compressive strength of not less than 2500 pounds per square inch (17.3 MPa), determined as specified under falsework removal in [502.3.4.2](#).

- (13) Do not drive any pile shell after filling the shell with concrete.

510.3.4.2 Bearing Value

- (1) Drive the shells for cast in place concrete piling to a bearing value not less than that the plans show.
- (2) Unless specified otherwise in the contract, determine the bearing value of each individual pile shell as specified in [section 508](#) for timber piling.

510.3.4.3 Penetration

- (1) Drive the shells for cast in place concrete piling to the minimum penetration specified in [section 508](#) for timber piling. The engineer may require preboring to achieve minimum penetration

510.3.4.4 Cutting Off Shells

- (1) After driving the metal shell and before placing the concrete core inside, cut the shell off at the elevation the plans show using a saw or cutting torch.
- (2) The contractor may splice and extend with suitable cutoffs delivered, or driven lengths of steel pile shells, if necessary.
- (3) The engineer may allow the contractor to produce pile lengths by splicing together suitable cutoffs, except do not use cutoffs less than 5 feet (1.5 m) in length to fabricate piling.
- (4) All pile shell cutoffs are the contractor's property. Dispose of any cutoffs not used in the work.

510.3.4.5 Prebored Holes

- (1) If the plans or contract special provisions require prebored holes, make them the length or depth the plans show. Unless directed otherwise, make the diameter of the hole approximately the same as the diameter of the pile. Backfill bored holes through roadway embankments that exceed the diameter of the piling with sand after driving the piling.

510.3.5 Concrete Cores

- (1) Except as specified in this subsection, conform to [section 501](#) for concrete core placement, protection and curing.
- (2) Remove any accumulated water or other foreign material from inside the shell before placing the concrete inside.
- (3) After the engineer inspects and approves the pile shells, deposit the concrete in each shell in one continuous operation, in a manner, and at a rate, that causes no air pockets. There is no requirement to use a tremie or downspout within the shell. Fill the shell completely with concrete and compact with a mechanical vibrator, or by other methods that satisfy the engineer, for as great a depth below the top as is possible.
- (4) Place steel reinforcement in the concrete core as the plans show and ensure it is in place when the level of concrete placement reaches the lower limits of the reinforcement.
- (5) Do not place concrete in shells that are within a 15 feet (5 m) radius of driving other shells. If necessary to place concrete within the above limits, cease driving operations and resume after the concrete cures for at least 7 days, or 3 days if using high early strength concrete. Except, if using grade A-FA, A-S, A-T, A-IS, or A-IP concrete and field operations are not controlled by cylinder tests, increase the time to 14 days. If field operations are controlled by cylinder tests, proceed with driving pile shells, with the engineer's approval, if cylinder tests show a compressive test of not less than 2500 pounds per square inch (17.3 MPa), determined as specified under falsework removal in [502.3.4.2](#).

510.3.6 Painting

- (1) Paint portions of the completed trestle or other exposed piling as specified for steel piling in [511.3.5](#).

510.4 Measurement

- (1) The department will measure holes the plans show or the special provisions specify as prebored by the linear foot acceptably completed, measured as the depth of the hole.
- (2) The department will measure the Piling CIP Concrete Delivered and Driven bid items by the linear foot acceptably completed. The measured quantity equals the sum of the lengths of piling delivered, driven, and left in place below cutoff.

510.5 Payment

510.5.1 General

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
510.2005	Preboring CIP Concrete Piling	LF
510.3000 - 3099	Piling CIP Concrete Delivered and Driven (inch)	LF

- (2) If the engineer requires preboring, but the contract does not contain the Preboring CIP Concrete Piling bid item, the department will pay for preboring as extra work.

510.5.2 Preboring Cast In Place Concrete Piling

- (1) Payment for Preboring CIP Concrete Piling is full compensation for boring; for providing and placing necessary backfill material; and for disposing of all material excavated by boring.

510.5.3 Cast In Place Concrete Piling Delivered and Driven

- (1) Payment for the Piling CIP Concrete Delivered and Driven bid items is full compensation for fabricating, furnishing, and delivering acceptable pile shells; for preparing, driving, splicing, and cutting off metal shells; for disposing of cutoffs not used; for painting if required; and for providing, placing, curing and protecting the concrete cores.
- (2) The department will pay an amount equivalent to the contract price for 6 feet of Piling CIP Concrete Delivered and Driven for field splices. The department will pay for one splice per pile under the Splices CIP Piling administrative item. The department will only pay for splices meeting the following conditions:
1. The contractor can not get the plan bearing capacity in the length the plans show.
 2. The contractor actually splices the pile.
 3. The spliced pile is acceptably driven to the plan bearing capacity.
- (3) The department will pay separately for steel reinforcement incorporated in the concrete core under the applicable section 505 bid item as specified in [505.5](#).
- (4) The department will not pay separately or additionally for providing a pile shell fabricated from cutoffs, as allowed under [510.3.4.4](#), or for providing and attaching the conical point or end plate to that fabricated shell.

SECTION 511 STEEL PILING

511.1 Description

- (1) This section describes furnishing, driving, cutting off, splicing if necessary, and painting if required, steel foundation piling or steel trestle piling.
- (2) This section also describes furnishing and attaching pile points to steel piling.

511.2 Materials

511.2.1 Steel HP Piling

- (1) Conform to the requirements for structural steel [506.2.2](#).
- (2) Unless the engineer directs otherwise, the contractor shall submit at, or before delivery of the steel HP piling the certified report of test or analysis as specified for structural steel mill inspection and testing in [506.3.21](#).

511.2.2 Steel Oil Field Pipe

- (1) Conform to ASTM, A 252, grade 3 with a minimum tensile strength of 120 000 pounds per square inch (413.7 MPa) or a Brinell Hardness Number (BHN) of 120. Conducting the onsite Brinell Hardness Test is the contractor's responsibility. Perform 2 hardness tests on one end of each pipe length. Weld piling with a BHN in excess of 180 according to the welding requirements of [506.3.19.1](#) and [511.3.4.4.2](#), and a certified welder shall visually inspect these welds. If replacing pipe, use an area of pipe within 3 percent below the area of steel HP piling that it replaces. The pipe shall have a minimum outside diameter of 7 3/4 inches (196 mm) and an allowable wall thickness of 3/8 inch (10 mm). Mark each piling on every load delivered to the project with a unique identification for each load and shall conform to the bill of lading. Make the marking durable and legible.
- (2) The contractor shall also furnish, at or before delivery, certification of the pipe's chemical composition to determine its carbon equivalency (CE). Ensure the CE does not exceed 0.55.

$$CE=C+1/6(Mn+Si+Cr+Mo+V)+1/15(Ni+Cu)$$

- (3) Use pipe delivered in a magnetized condition for non-welded applications only.

511.3 Construction

511.3.1 Ordering Piling

- (1) Consider the estimated lengths of piling the plans show as approximate only and determined for design and estimating purposes from a few soil soundings taken at the site. It is the contractor's responsibility to furnish steel in sufficient lengths to obtain the required penetration and specified bearing for each pile.

511.3.2 Fabrication and Delivery

- (1) Use the structural steel shapes the plans show to fabricate all steel foundation or trestle piling, except the contractor may furnish steel oil field pipe instead of the steel HP piling unless the contract states otherwise. Fabricate and deliver all steel piling as specified in [section 506](#), except as specified below. Submit a certified report of test or analysis to the engineer at or before delivery of the piling.
- (2) Paint that portion of the steel piling exposed in the completed work as specified for painting in [511.3.5](#).
- (3) Except for piling made from cutoffs with the engineer's permission, furnish steel piling up to and including 20 feet (6 m) in length in one unwelded piece. Piling from 20 to 50 feet (6 m to 15 m) in length may have 2 field or shop welded splices; and the contractor may furnish piling over 50 feet (15 m) in length with 4 splices, unless the contract provides otherwise.

511.3.3 Driving Equipment

- (1) Equipment for driving steel piling shall conform to [508.3.3](#) for equipment for driving timber piling. Cut the head of the pile squarely and provide a driving cap to hold the axis of the pile in line with the axis of the hammer.

511.3.4 Driving

511.3.4.1 General

- (1) Drive steel piling as specified in [508.3.5](#) for timber piling, except as specified below.

511.3.4.2 Bearing Value

- (1) Drive piles to a bearing value not less than that the plans show.
- (2) Determine the bearing value for each individual pile as specified in [section 508](#) for timber piling.

511.3.4.3 Penetration

- (1) Drive steel piles to the minimum penetration specified in [section 508](#) for timber piling.

511.3.4.4 Pile Splicing

511.3.4.4.1 General

- (1) Make pile splices as specified shell lengths and splices in [510.3.2](#).
- (2) The splice shall develop the full strength of the pile. If details for splices are incorporated in the plans, conform to them.

511.3.4.4.2 Oil Field Pipe

- (1) Position backup rings flush with the joint and place as specified in paragraph 3.13 of AASHTO/AWS D1.5. The rings shall allow the joint to contract freely as the weld cools. Make tack welds the smallest size necessary to hold the pipe ends in alignment for welding.
- (2) Preheat for a distance of 5 inches (125 mm) on both sides of the weld. Preheat steel pipe with a CE less than 0.35 to 100 F (38 C). Preheat steel pipe with a CE between 0.35 and 0.45 inclusive to 250 F (121 C) and preheat steel pipe with a CE between 0.45 and 0.55 inclusive to 400 F (204 C).
- (3) Protect the pipe ends from high winds and precipitation during the welding process by housing or sheltering.
- (4) The contractor may use engineer-approved threaded connections instead of welded connections.

511.3.4.5 Cutting Off Piles

- (1) After driving all piles in a unit, cut the tops off the piles at the elevation the plans show and according to the plan details.

511.3.4.6 Pile Cutoffs

- (1) The contractor may splice and extend delivered or driven lengths of steel piling with suitable cutoffs, if necessary.
- (2) The engineer may allow the contractor to produce pile lengths by splicing together suitable cutoffs, except, do not use cutoffs less than 5 feet (1.5 m) in length to fabricate this piling.
- (3) All pile cutoffs are the contractor's property. The contractor is responsible for disposing of any cutoffs not used in the work.

511.3.4.7 Oil Field Pipe

- (1) Remove soil, water, or other material within the pile to the bottom of the footing elevation. The contractor may install a suitable barrier at this elevation instead of filling any void with material acceptable to the engineer.

511.3.5 Painting

511.3.5.1 General

- (1) Paint the exposed portions of the completed trestle or other exposed steel piling to conform to the 2-coat paint system or 3-coat paint system specified below. The paint shall extend from the top of the driven pile to a point not less than 4 feet (1.2 m) below streambed or ground line. Paint the piling before driving.
- (2) Prepare the surface and apply the paint as specified in [section 517](#), except blast clean the piling to conform to SSPC-SP 6.
- (3) Handle pilings with padded slings, nonmetallic slings, or softeners to minimize paint damage. Repair all damaged paint exposed above water or above ground line.

511.3.5.2 Two-Coat Paint System

- (1) This system consists of 2 coats of paint from an department-approved manufacturer with a dry film thickness of 8 mils (0.20 mm) minimum and 10 mils (0.25 mm) maximum. Ensure a minimum cure time of 7 days elapses before exposing to water.

511.3.5.3 Three-Coat Paint System

- (1) This system consists of an approved-approved organic zinc rich primer and 2 coats of aluminum paint. Apply the 2 top coats as follows:
- Ensure that the aluminum paint for topcoats is made with aluminum pigment paste and varnish vehicle conforming to AASHTO M 69, type I, except use a non-leafing pigment paste for the first top coat.
 - Tint the first topcoat by adding Paste in Oil, as contained in ASTM D 261, in the proportion of 3 ounces per gallon (23 g/L) of vehicle.
 - Allow 2 days cure time between coats of paints.
 - Do not apply aluminum paint to any portion of pile that will end up imbedded in fresh portland cement concrete.

511.4 Measurement

- (1) The department will measure the Piling Steel Delivered and Driven HP bid items by the linear foot acceptably completed. The measured quantity equals the sum of the lengths of piling delivered, driven, and left in place below cutoff.
- (2) The department will measure Pile Points as each individual unit acceptably completed.

511.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
511.2100 - 2199	Piling Steel Delivered and Driven HP (inch) (lb)	LF
511.3000	Pile Points	EACH

- (2) Payment for the Piling Steel Delivered and Driven HP bid items is full compensation for fabricating, furnishing, and delivering acceptable piling; for preparing, and driving; for splicing, cutting off, and painting, if required, the steel piling; for removing upheaved material; and for disposing of piling cutoffs not used.
- (3) The department will pay an amount equivalent to the contract price for 9 feet of Piling Steel Delivered and Driven HP for field splices. The department will pay for one splice per pile under the Splices HP Piling administrative item. The department will only pay for splices meeting the following conditions:
1. The contractor can not get the plan bearing capacity in the length the plans show.
 2. The contractor actually splices the pile.
 3. The spliced pile is acceptably driven to the plan bearing capacity.
- (4) The department will not pay separately or additionally for providing a piling fabricated from cutoffs, as allowed under [511.3.4.6](#).
- (5) Payment for Pile Points is full compensation for providing and attaching the points.

SECTION 512 STEEL SHEET PILING

512.1 Description

- (1) This section describes furnishing permanent and temporary steel sheet piling.

512.2 Materials

512.2.1 Permanent Steel Sheet Piling

- (1) Furnish permanent sheet piling conforming to ASTM A 328 and with the section modulus, the plans or special provisions specify.
- (2) Unless specified otherwise, do not furnish previously used material under the Piling Steel Sheet Permanent bid items.
- (3) Unless the engineer directs otherwise, the contractor shall submit before or at delivery of steel sheet piling the certified report of test or analysis as specified for mill inspection and tests in [506.3.21](#).

512.2.2 Temporary Steel Sheet Piling

- (1) Furnish temporary steel sheet piling with a section modulus equal to or greater than the plans show. The contractor may employ previously used steel sheet piling in good condition instead of new material. Remove and dispose of temporary sheet piling when no longer needed.

512.3 Construction

512.3.1 Driving and Cutting Off

- (1) If possible, drive and cut off the steel sheet piling as specified in [section 511](#).

512.3.2 Wales

- (1) Brace the steel sheet piling with waling strips as the plans show. Preferably, make the wales one length between corners and bolt to the piles.

512.3.3 Painting

- (1) Paint permanent steel sheet piling as specified for painting steel piling in [511.3.5](#).

512.4 Measurement

- (1) The department will measure Piling Steel Sheet Permanent Delivered by the square foot acceptably completed. The department will obtain the measured quantity by multiplying the length of the wall the plans show by the length of sheeting required.
- (2) The department will measure Piling Steel Sheet Permanent Driven by the square foot acceptably completed. The department will measure the area of the wall from the sheet pile tip elevation to the top cutoff. The department will make no allowance for overlap of the piles.
- (3) The department will measure Piling Steel Sheet Temporary by the square foot acceptably completed. The department will measure the area of the wall from the sheet pile tip elevation to the retained grade elevation and add an additional one foot (300 mm) height of wall above the retained grade. The department will make no allowance for overlap of the piles.

512.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
512.0500	Piling Steel Sheet Permanent Delivered	SF
512.0600	Piling Steel Sheet Permanent Driven	SF
512.1000	Piling Steel Sheet Temporary	SF

- (2) Payment for Piling Steel Sheet Permanent Delivered is full compensation for providing and delivering acceptable piling for this work.
- (3) Payment for Piling Steel Sheet Permanent Driven is full compensation for driving, cutting off, disposing of cutoffs, and painting if required.
- (4) Payment for Piling Steel Sheet Temporary is full compensation for providing, driving, and removing.

SECTION 513 RAILING

513.1 Description

- (1) This section describes furnishing and erecting railing fabricated from steel pipe, structural steel, tubular steel, steel plate beam, or aluminum.

513.2 Materials

513.2.1 General

- (1) Furnish materials conforming to the following:

Structural steel.....	section 506
Miscellaneous metals	section 506
Steel pipe.....	section 506
Pipe fittings	section 506
Sheet lead	section 506
Paint	section 517
Painting structures	section 517
Steel plate beam.....	section 614

- (2) Use black, round, steel pipe for the rails and posts for pipe railing.
- (3) Fabricate steel railing using structural steel shapes the plans show.
- (4) Use steel plate beam for the rails of steel railing, type W, conforming to plan details for W beam or thrie beam and conforms to [614.2.3](#).
- (5) Under the Railing Tubular Type H bid item, furnish either tubular aluminum railing, or tubular steel railing, except if furnishing railings for adjacent structures on a dual highway then use the same material.
- (6) Under the Railing Tubular Type F bid item, furnish only tubular steel railing.
- (7) For tubular aluminum railing, conform to [513.2.2](#) for aluminum railing below.
- (8) For tubular steel railing, conform to [513.2.4](#) for steel railing below.

513.2.2 Aluminum Railing

513.2.2.1 General

- (1) For all material for the various parts of the aluminum railing, except the anchor bolts, toggle bolts, and other miscellaneous hardware, use aluminum alloy and conform to the requirements specified.
- (2) If using railing from an department-approved fabricator, provide a certified report of test or analysis for the railing tubes, cast, and extruded shapes for posts, and anchor bolts to the engineer upon request.
- (3) If using railing that is not from an department-approved fabricator, furnish a certified report of test or analysis to the engineer for the railing tubes, cast and extruded shapes for posts, and anchor bolts. For miscellaneous hardware required to complete installation (toggle bolts, washers, nuts, bolts, screws, pins, clamps, shims, etc.), furnish a certificate of compliance to the engineer.
- (4) Dimensional tolerances for aluminum products shall conform to ASTM B 210.

513.2.2.2 Cast Aluminum Railing Posts

- (1) Furnish material for railing posts conforming to ASTM B 108, Alloy A 444.0.

513.2.2.3 Round or Square Tubular Rail and Extrusions

- (1) Furnish material for round or square aluminum tubes and other extruded shapes conforming to ASTM B 221, Alloy 6061-T6 or Alloy 6351-T5.
- (2) Ensure that the extruded finish of the tubing is free from nicks, blemishes, and discoloration marks.

513.2.2.4 Shims

- (1) Use the size shims the plans show. Use material for shims conforming to ASTM B 209, Alloy 1100.

513.2.2.5 Stainless Steel Nuts, Bolts, and Washers

- (1) Use nuts, bolts, and washers of the size the plans show and conforming to the following:
 - Hex nuts ASTM F 594
 - Hex bolts and anchor boltsASTM F 593, any type in alloy groups 1, 2, or 3
 - Washers ASTM A 240

513.2.2.6 Plates

- (1) Use material for plates conforming to ASTM B 209, Alloy 6061-T6.

513.2.2.7 Standard Structural Shapes

- (1) Use material for standard aluminum structural shapes conforming to ASTM B 308.

513.2.2.8 Weld Filler

- (1) Use material for weld filler conforming to AWS A 5.10, Alloy ER5356.

513.2.2.9 Toggle Bolts

- (1) Use toggle bolts made of steel, conforming to the plans. Make the assembly from the material specified below:
 - Toggle bolt and pin Cold finished steel heat-treated Brinell 311-363 ASTM A 354.
 - Toggle washer Hot rolled steel ASTM A 570. Manufacturer's standard washer.
 - Spacer nut Grade 1213, ASTM A 108. Cold finished steel heat-treated ASTM A 325.
- (2) Cadmium plate the complete assembly of toggle bolts according to ASTM B 766, type III, class 12.

513.2.2.10 Miscellaneous Hardware

- (1) Provide hardware conforming to the following:
 - Stainless steel clamping barsASTM A 276, any type in the 300 series
 - Stainless steel cap screws.....ASTM F 593, any type in alloy groups 1, 2, or 3
 - Aluminum clamping bars ASTM B 211, Alloy 6061-T6
 - Cast aluminum washersASTM B 26, Alloy 356.0
 - Aluminum pins ASTM B 211, Alloy 6061-T6

513.2.3 Anchor Bolts

- (1) Use anchor bolts, nuts, and washers for anchoring aluminum railing to structures made of stainless steel and of the size, the plans show.
- (2) The contractor may use anchor crossbars of structural carbon steel. Use the same material requirements as well as the shape of nuts and type of threads as specified for bolts and nuts in [513.2.2.5](#).
- (3) Use anchor bolts for anchoring steel railing to structures made of the material, size, and style the plans show. Furnish them with regular hexagon nuts and standard flat washers. Hot-dip zinc coat the upper 3 1/2 inches (90 mm) of the anchor bolts, nuts, and washers according to ASTM A 153, class C. Use only nuts and anchor bolts manufactured with sufficient clearance to allow the nuts to run freely on the bolts after coating. Apply a good grade of heavy grease to the bolt threads before applying the nuts.

513.2.4 Steel Railing

- (1) All material shall conform to the requirements the plans show or as specified below.
- (2) If the railing is from an department-approved fabricator, furnish a certified report of test or analysis for the railing pipe, plate beam and tubing, and component parts of the posts and anchor bolts upon the engineer's request.
- (3) If the railing is not from a department-approved fabricator, furnish a certified report of test or analysis to the engineer for the railing pipe, plate beam and tubing, and the component parts of the posts and anchor bolts. For miscellaneous hardware and objects required for completing the installation, submit a certificate of compliance to the engineer.

513.3 Construction

513.3.1 General

- (1) For constructing railing, conform to [section 506](#) for steel bridges, except as specified otherwise below. Submit shop drawings for structural steel, miscellaneous metals, or aluminum as specified in [section 506](#) before ordering or fabricating the material.
- (2) Before erecting the railing, swing the spans free from falsework. Make the railings line and grade true and do not follow any unevenness of curb, sidewalk, or wall that supports the railing. Unless the plans require otherwise, construct the railing with the posts normal to the grade of the structure.
- (3) Unless the plans provide otherwise, set the anchor bolts in the supporting concrete during concrete placement. Place the anchor bolts in a manner that provides correct and true railing alignment. Set anchor bolts at the proper depth to provide for the bolt projecting through the completed work not more than 3/8 inch (10 mm) beyond the nut.
- (4) If required to set anchor bolts in holes drilled in concrete, use bolts with expansion sleeves of an engineer-approved type. Place the bolts and expansion sleeves in the drilled holes and the firmly anchor bolts before tightening the nuts to their final position.
- (5) Place any shims the plans require under each railing post, and end base plate of pipe, and structural steel railings.
- (6) Paint the exposed metal of pipe, structural steel, and non-zinc-coated tubular steel railing according to the epoxy system as specified in [517.2.4](#) and the following subsections. Do not paint aluminum railing, zinc coated steel plate beam, and zinc coated tubular steel railing.

513.3.2 Pipe Railing

- (1) Construct pipe railing with pipe rails and pipe posts conforming to plan details. Join the posts and rails together by screw fittings, or by welding, as the plans show. Grind the welded joints to a smooth finish. Do not splice pipe rails with screw fittings between the posts.

513.3.3 Steel Railing

- (1) Saw the vertical members of the railing to length; do not shear them. Fabricate tubular steel railing according to plan details.
- (2) After complete fabrication, zinc coat the tubular steel railing, type H, according to ASTM A 123. Blast clean steel railing according to SSPC-SP 6 before applying zinc coating. Paint tubular steel railing type F specified for tubular steel railing in [513.3.1](#).
- (3) Ship, handle, and erect the zinc coated tubular steel railing in a manner to preclude scratching or marring the spelter coating. Repair damaged zinc coating as specified for its repair in [635.3.4](#).

513.3.4 Aluminum Railing

- (1) For welding aluminum railing, conform to [641.2.7.7](#) and [641.3.2.3](#) for procedures and materials. Fabricate according to the Fabrication of the Aluminum Association's Specifications for Aluminum Structures.
- (2) Do not oxygen cut materials.
- (3) Blast clean, or polish and burnish, the cast posts so that the finished castings have surfaces of uniform texture with a smooth, uniform appearance.
- (4) Before lying out or working on aluminum materials, ensure they are straight. If straightening is necessary, straighten in a manner that causes no injury to the appearance or strength of the metal. The engineer will reject material with sharp kinks and bends.
- (5) Store the aluminum railing above the ground on platforms, skids, or other suitable supports. Protect the material from moisture and keep it free from oil, grease, dirt, and contact with dissimilar metals until the railing is complete.
- (6) Neatly finish those portions of work exposed to view. Handle, ship, and erect the material in a manner to preclude any scratching, denting, or other defects that may affect the railing durability or appearance.

513.4 Measurement

- (1) The department will measure the Railing Pipe, Railing Tubular , and Railing Steel bid items as a single lump sum unit for each structure acceptably completed.

513.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
513.2000	Railing Pipe (structure)	LS
513.4000 - 4099	Railing Tubular (type) (structure)	LS
513.6000	Railing Steel (structure)	LS
513.7000 - 7099	Railing Steel (type) (structure)	LS

- (2) Payment for the Railing Pipe, Railing Tubular, and Railing Steel bid items is full compensation for providing, fabricating, transporting, and erecting the railing; for painting pipe and steel railing; for zinc coating or painting steel tubular railing; for providing and placing metal shims under the bases if required; and for providing and placing the anchor bolts.

SECTION 514 FLOOR DRAINS, DECK DRAINS, AND DOWNSPOUTS

514.1 Description

- (1) The section describes furnishing and installing floor drains, drain frames, grates and pipes, and inserts; deck drains, and downspouts.

514.2 Materials

- (1) Furnish materials conforming to the following:

Structural carbon steel	506.2
Miscellaneous metals	506.2
Paint	section 517
Corrugated steel pipe	section 521
Iron castings	section 611
Pipe underdrains.....	section 612

- (2) Use structural carbon steel or cast iron for the frames and grates of floor drains.
- (3) After fabrication, blast clean and zinc coat the frames and grates of floor drains fabricated from structural steel, and steel pipes, clamps, fittings and anchors for steel downspouts and drains according to ASTM A 123, except as specified otherwise for drain frames and inserts for adjusting floor drains in [514.3.2](#).
- (4) Unless specified otherwise, uniformly coat perforated 1/2-round pipe and other steel parts of deck drains with asphaltic material conforming to AASHTO M 190. Open any perforations filled during coating before installation.
- (5) For pipes and fittings for downspouts and drains use either steel pipe conforming to [506.2.3.6](#), or reinforced thermosetting resin piping (RTRP) conforming to ASTM D 2996, Designation Code RTRP-11AF-3112 and complying with ASTM D 2310, Classification RTRP-11AF at 23 C. All of these pipes shall comply with AWWA Standard C950, Class 150. Use epoxy adhesive for connections.
- (6) Use stainless steel pipe anchors for attaching RTRP to the piers as the plans show.
- (7) Attach downspouts using an engineer-approved adhesive anchor system. Provide stainless steel anchor bolts, nuts, and washers conforming to [513.2.2.5](#). Unless the plans show otherwise, use 1/2-inch diameter (M 12) anchor bolts.

514.3 Construction

514.3.1 Floor Drains

- (1) Fabricate, zinc coat, assemble, and erect floor drains as specified in [section 506](#), as specified below and as the plans show.
- (2) Set the floor drain so that the grate is at the elevation the plans show with respect to the plane of the bridge floor and finish the floor to the drain as the plans show.

514.3.2 Adjusting Floor Drains

- (1) If the plans show or the contract requires, furnish and install new drain frames and inserts conforming to plan details on existing drains.
- (2) Fabricate, blast clean, and paint with a shop coat or prime coat of inorganic zinc-rich paint all floor drain frames and inserts. After installation, touch up the assemblies with an department-approved organic zinc-rich primer in any area that sustains damage to the prime coat.
- (3) After installation and after placing and curing the adjacent concrete, paint the exposed surfaces of the inserts and frames with a coat of an department-approved ready-mixed leafing aluminum paint. Brush clean the existing drain grates and apply a similar coat of leafing aluminum paint.

514.3.3 Deck Drains

- (1) Fabricate, assemble, and erect deck drains according to the plans and the contract special provisions.

514.3.4 Downspouts

- (1) Fabricate and install downspouts according to the plan details.
- (2) Make steel pipe connections with zinc coated clamps or fittings.

- (3) If the plans require, construct concrete aprons using grade A, A-FA, A-S, A-T, A-IS, or A-IP concrete conforming to plan details.
- (4) Unless specified otherwise, fabricate downspouts from 6-inch (150 mm) pipe.
- (5) Prepare and submit shop drawings to the engineer as specified for submission in [506.3.2](#).

514.3.5 Reinforced Thermosetting Resin Piping

- (1) Join the pipe and fittings with an epoxy adhesive on matching tapered bell and spigot. Use the epoxy adhesive in strict conformance with the pipe manufacturer's recommendations on temperature limitations.
- (2) Paint the exterior of the pipe and all laterals and elbows with a solvent based paint the pipe manufacturer recommends. Match the piping paint color to concrete color attaching it to, or the girder color if applicable. Apply the paint in a shop, with field touch-up as necessary.
- (3) Space pipe anchors at 12-foot (3.7 m) maximum centers. Place at least one pipe anchor at each elbow and 2 pipe anchors at each lateral joint connection. Paint pipe anchors in the shop and make them the same color as the painted pipe downspouts.
- (4) Anchor the bolt anchorage system by drilling into concrete, and installing the adhesive cartridge and anchor rod assembly according to the manufacturer's specifications.

514.4 Measurement

- (1) The department will measure the Floor Drains bid items as each individual drain acceptably completed.
- (2) The department will measure Adjusting Floor Drains as each individual frame acceptably completed.
- (3) The department will measure the Deck Drains bid items as a single lump sum unit for each structure acceptably completed.
- (4) The department will measure the Downspout bid items by the linear foot acceptably completed, measured in place along the centerline of pipe, from end to end through all fittings.

514.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
514.0400 - 0499	Floor Drains (type)	EACH
514.0900	Adjusting Floor Drains	EACH
514.1000	Deck Drains (structure)	LS
514.2600 - 2699	Downspout (inch)	LF

- (1) Payment for the Floor Drains bid items is full compensation for providing and zinc coating the floor drains, including the frames, grates, and pipes; and for all necessary form work.
- (2) Payment for Adjusting Floor Drains is full compensation for providing floor drain frames and inserts including all new materials; and for required welding, cleaning, and painting.
- (3) Payment for the Deck Drains bid items is full compensation for providing all pipes and other metal parts required for draining bridge decks, and for asphaltic coating.
- (4) Payment for the Downspout bid items is full compensation for providing, fabricating, cleaning, zinc coating if required, transporting, erecting, and painting if required the downspout, including all fittings, elbows, cleanouts, straps, anchors and bolts required for attaching the downspout to the structure; and for providing and placing concrete apron at the location designated, if required.

SECTION 515 STEEL GRID FLOORS

515.1 Description

- (1) This section describes furnishing and erecting steel grid floors of the open type, or concrete filled type.

515.2 Materials

- (1) Furnish materials conforming to the following:

Concrete	section 501
Paint	section 517

- (2) All steel in steel grid floors shall conform to ASTM A 36, with a minimum copper content of 0.2 percent.
- (3) Zinc coat open type grid floors according to ASTM A 123.
- (4) For concrete filled type floors, use grade C, C-FA, C-S, C-IS, or C-IP concrete.

515.3 Construction

515.3.1 Fabrication

- (1) Manufacture the steel grid floors to conform to the thickness, section, loading, and other requirements the plans show; and so if assembled in place they conform to the camber the plans show. The engineer will reject steel grid floors not within 1/2 inch (13 mm) of specified camber. Serrate the top edges of open type grid floors.
- (2) If fabricating the floor with the main elements normal to the centerline of the roadway, extend the units the full width of the roadway for roadways up to 40 feet (12.2 m) wide. If multiple units are allowed, extend the units over at least 3 panels. If the main elements are parallel to the centerline of the roadway, extend the section over not less than 3 panels. If joints are required, weld the ends of all main floor members at the joints over their full cross sectional area to provide full continuity and, preferably, place joints, if assembling the floor in place, over a supporting member.
- (3) Before fabricating, submit complete detailed shop drawings to the engineer for approval. These drawings shall show the spacing and size of all component parts, the size and length of welds, splices and trims, and complete assembly details, including size and location of recommended erection welding.
- (4) Fabricate and construct steel grid floors being filled with concrete to provide adequate support for the concrete filler.

515.3.2 Erection

- (1) Assemble the units or sections of the grid floor on the structure and weld the abutting main elements and connecting members between the sections to provide full continuity for the entire floor or between any points the plans indicate. Weight the floor assembly down or clamp it in place to make a tight joint with full bearing on its supports before welding. If there is a roadway crown, weld beveled bars to the stringer flange to provide a bearing surface parallel to the crown, unless placing the stringers with their vertical axes normal to the crown. Use the location, size, and length of the welds that the manufacturer recommends or as the engineer approves.

515.3.3 Welding

- (1) Perform all shop and field welding as specified in [506.3.19](#), and as follows:
 - Perform welding on dry material.
 - Ensure an ambient temperature above 32 F (-18 C) at welding time.
 - Ensure welding surfaces are clean and free from paint, grease, rust, or other material that prevent a proper weld.

515.3.4 Painting

- (1) Spot paint all damaged places in the zinc coating and all field welds with an department-approved zinc-rich paint. Clean all field welds of scale or slag and neutralize the welds as specified in [517.3.1.3.1](#) before spot painting.

515.3.5 Concrete Filler

- (1) Mix, place, and cure the concrete as specified in [section 501](#) and [section 502](#). Unless directed otherwise, compact the concrete thoroughly by vibrating. The vibrating device and manner of operation are subject to the engineer's approval.

515.4 Measurement

- (1) The department will measure the Steel Grid Floor bid items by the square foot acceptably completed.

515.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
515.4000	Steel Grid Floor Open (inch)	SF
515.5000	Steel Grid Floor Concrete Filled (inch)	SF

- (2) Payment for the Steel Grid Floor bid items is full compensation for fabricating, zinc coating, and furnishing the steel grid floor; for providing paint and concrete; and for erecting and welding, painting, placing and curing concrete.

SECTION 516 WATERPROOFING

516.1 Description

- (1) This section describes furnishing, applying rubberized membrane waterproofing, and dampproofing to concrete surfaces of structures.

516.2 Materials

516.2.1 Dampproofing

- (1) Furnish asphalt dampproofing conforming to ASTM D 449 type II and primer conforming to ASTM D 41.
- (2) Furnish coal-tar pitch dampproofing conforming to ASTM D 450 type I and a primer conforming to ASTM D 43.
- (3) Furnish emulsified asphalt dampproofing conforming to ASTM D1227 type II class 1 and a manufacturer approved primer.

516.2.3 Rubberized Membrane

- (1) Select the rubberized membrane, primer, and mastic from the department's approved products list. Use membrane at least 60 mil (1.5 mm) thick.

516.3 Construction

516.3.1 General

- (1) Do not perform dampproofing and waterproofing in wet weather or if the air temperature or the concrete temperature is below 45 F (7 C), unless the engineer specifically allows.
- (2) Do not cure surfaces that require dampproofing or waterproofing with membrane curing material.
- (3) Cure the concrete and finish the concrete surface as specified for concrete surface finish in [502.3.7](#) before applying dampproofing or waterproofing.
- (4) During primer application, ensure the concrete surface is dry and thoroughly clean, free from contaminants, dust, or other loose material.
- (5) Apply at a material temperature that allows uniform application. If required, heat material uniformly in a kettle with an armored thermometer. Do not heat asphalt above 350 F (177 C) or coal-tar pitch above 250 F (121 C).

516.3.2 Dampproofing

- (1) Under the Dampproofing bid item, provide a prime coat and a finish coat of asphalt, coal-tar pitch, or emulsified asphalt.
- (2) Apply a light coating of the primer to the concrete surface after preparation, cleaning, and drying. Apply the primer to thoroughly and uniformly coat the concrete surface. Apply the finish coat after the prime coat cures but is still tacky to the touch.
- (3) Apply asphalt, coal-tar pitch, or emulsified asphalt so that it uniformly and completely covers the primed surface. Use no less than 4 1/2 gallons, for each 100 square feet (19 L/10 m²) of surface, of asphalt, coal-tar pitch, or emulsified asphalt.

516.3.3 Rubberized Membrane

- (1) Under the Rubberized Membrane Waterproofing bid item, provide a prime coat, one layer of a preformed rubberized asphalt and plastic film membrane, and cold-applied rubberized asphalt mastic.
- (2) Prime the concrete surfaces with the membrane manufacturer's primer, applied by brush or roller at the rate of 250 to 350 square feet per gallon (6 to 9 m²/L). Let the primer dry one hour or until tack free. Re-prime all primed surfaces not covered within 36 hours. Do not prime dense surfaces like metal, but ensure it is clean, dry, and free of grease, oil, dust, or other contaminants.
- (3) Apply a single layer of membrane to the accepted primed surface. Double cover all corners with a double layer of membrane by applying an initial 18-inch (450 mm) wide strip centered along the axis of the corner. Chamfer or round the exterior corners.
- (4) Apply a double layer of membrane around drains, posts, bolts, or other protrusions and liberally coat them with mastic next to seams and protrusions after applying the membrane.

- (5) Apply a trowelled bead of cold-applied rubberized asphalt mastic to the perimeter of the membrane placed in any day's operation and to all outside edges of membrane after placing the membrane.
- (6) Make a careful inspection of the membrane and patch any ruptures, misaligned seams, or other discontinuities with membrane and place any required backfill material against the membrane.

516.4 Measurement

- (1) The department will measure Dampproofing and Rubberized Membrane Waterproofing by the square yard acceptably completed.

516.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
516.0100	Dampproofing	SY
516.0500	Rubberized Membrane Waterproofing	SY

- (2) Payment for Dampproofing and Rubberized Membrane Waterproofing is full compensation for heating materials; for applying prime coats, mastic, and asphalt, coal-tar pitch, or emulsified asphalt; and for placing preformed membrane.

SECTION 517 PAINT AND PAINTING

517.1 Description

- (1) This section describes furnishing paint materials and applying paint to steel or timber structures, including structural steel, miscellaneous metal or lumber, or timber parts of other structures. This work also includes, unless specified otherwise in the contract, preparing surfaces for painting, applying paint, protecting and drying the paint coatings; protecting traffic and property upon and in the vicinity of the structure; and protecting of all portions of the structure against disfigurement by paint or paint materials.
- (2) This section also describes shop cleaning, the furnishing and shop application of a complete epoxy coating system on new structural steel, and the field cleaning and repair of surfaces field welded or damaged in shipping, handling and erecting the structural steel.

517.2 Materials

517.2.1 General Requirements

- (1) All coatings or paints shall conform to the requirements specified for the type of coating or paint named.
- (2) Furnish factory mixed paint or field mix according to the manufacturer's directions and as the contract directs.
- (3) Ready-mixed paints shall not settle or cake in the container, but should break up readily with a paddle to a smooth, uniform paint of good brushing consistency that dries without streaking, wrinkling, running, or sagging if painted on smooth, vertical surfaces. Prime and undercoats shall dry to a dull gloss, and finish coats to a full gloss. If required, colors and hiding powers shall equal those of samples the department furnished. Any proportions specified in formulae are by weight, unless indicated otherwise in the requirements for specific paint.

517.2.2 Containers

- (1) Generally, paint shall arrive packaged in strong, tight, standard commercial, 5 US standard-gallon (19 L) capacity metal containers, except for the fractional parts of units. Package the fractional parts in one US standard-gallon (3.8 L) capacity metal containers. If mechanical means for mixing and stirring are provided at the job site or painting facility, then the contractor may furnish the paint in 30 gallon (114 L) or other suitable size metal containers.
- (2) Mark each container with the name and address of the manufacturer, the type of paint contained, and the date of manufacture. Use tight-fitting covers on the containers and arrange them so that the inspector may attach wire-lead seals.
- (3) Except as specified above for mixing paint mechanically, mix paint on the job in containers with not more than 15 gallons (57 L) capacity.

517.2.3 Inspection, Sampling, and Testing

- (1) Paint sampling and inspection normally takes place at the point of manufacture; the department may sample the paint at the fabricating shop or in the field. The engineer will obtain samples of paints purchased directly by the state, either for approval at their point of manufacture, or at their destination as indicated, either at the time contracts are awarded, or in the invitation for bids.
- (2) If inspecting paints at the point of manufacture, the manufacturer shall furnish, if requested, any formulae required to determine the ingredients before making the paints. The manufacturer shall allow the inspector to check the makeup and grinding of paint batches and shall allow test sampling of any or all batches. The manufacturer also shall furnish, if requested, any formulae required to determine specification conformance.
- (3) Take representative samples of all ready-mixed paints after thoroughly mixing the paints. Consider one container chosen at random from each lot or batch for each coat, or if a batch or lot exceeds 500 gallons (2000 L), one container for each 500 gallon (2000 L) increment or fraction thereof, as representative. Take a one-pint (0.5 L) sample from the representative container in the inspector's presence. It is the contractor or manufacturer's responsibility to ensure paint mixing occurs in a container that allows sampling of the paint it contains. Take field samples only from paint that is on the job. Take samples in fabricating shops from containers of paint proposed for the specific bid item of work.
- (4) Perform tests according to applicable standard methods of ASTM or AASHTO.

- (5) The engineer may waive sampling and testing requirements for quantities of 5 gallon (19 L) or less of paint of any single formulation required for each project, provided the paint purchased is from stock that demonstrated a satisfactory service record.

517.2.4 Structural Steel Paint-Epoxy System

517.2.4.1 General

- (1) The epoxy system consists of a prime or shop coat of inorganic zinc-rich paint, an intermediate shop coat of high-build epoxy paint, and a protective shop coat of urethane paint.
- (2) The contractor shall furnish and apply paints conforming to the requirements of the epoxy system as specified in the special provisions.

517.2.4.2 Coating System

- (1) The contractor shall select a complete coating system from one of the department-approved coating systems shown in the contract. Use a white epoxy, the urethane coating materials shall match the color represented by the number the plans show according to Federal Standard Number 595b. The contractor shall supply the engineer with the product data sheets before applying any coating. The product data sheets shall indicate the mixing and thinning directions, the recommended spray nozzles and pressures, the minimum drying time for shop applied coats, the recommended procedures for painting zinc coated bolts, nuts and washers, the telephone number for technical service and other pertinent information.

517.2.4.3 Zinc Coating

- (1) Zinc coat the bearing assemblies specified in [506.2.8](#). Coat any other structural members and parts that require zinc coating according to ASTM A 123, after blast cleaning.
- (2) High strength bolts, nuts, and washers shall conform to the material requirements of [506.2.5](#) and be hot-dip zinc coated as specified in [506.2.5.1](#).

517.2.5 General-Purpose White Exterior Alkyd Wood Primer

517.2.5.1 General

- (1) This subsection covers a ready-mixed modified alkyd prime coat used as a primer in a 3-coat system on highway posts. This is a lead free paint.
- (2) The paint shall not skin, liver, curdle or thicken materially in the container. It shall brush easily at package consistency and allow lapping without difficulty. It shall conform to or exceed the performance requirements, not necessarily the composition, of Commercial Item Description A-A-2336A.

517.2.5.2 Composition and Properties

- (1) Furnish material conforming to the following:

PIGMENT

Percent by weight	49.0%
Titanium dioxide	16.0%
Calcium carbonate, silica/silicates	33.0%

VEHICLE

Percent by weight	51.0%
Soya and tall alkyd resin	24.0%
Aliphatic hydrocarbon solvent	23.0%
Driers and additives	4.0%
Total	100%

FINISHED PAINT TECHNICAL DATA

Generic type.....	Alkyd Resin, flat finish, exterior primer
Color	White
Gloss or sheen	Flat 0-15 units at 59 F (15 C)
Dry time.....	Touch: 4-8 hours
At 77 F (25 C), 50% RH	Recoat: 24 hours
Flash point, closed cup	108 F (42 C)
VOC, Maximum as packaged	2.92 lb/gal (350 gm/L)
Solids by Volume (percent)	56% +/- 2%

Solids by Weight (percent)	74% +/- 2%
Weight per gallon (L), pounds (kg)	3 (1.38)
Coverage	108 sq ft/gal (10 m ² /L) at 4 mils (0.1 mm) wet, 2.4 mils (0.06 mm) dry
Clean-up Solvent	Mineral Spirits
Type of Cure	Oxidation

517.2.6 White Paint for Wood - Intermediate and Finish Coat

517.2.6.1 General

- (1) This subsection covers a ready-mixed, ready-to-apply white paint for exterior exposure, used for an intermediate and finish coat in a 3 coat system on marker posts or other wooden structures. This is a lead-free paint.

517.2.6.2 Composition and Properties

- (1) Furnish material conforming to the following:

PIGMENT

Percent by weight	48.0% min to 51.0% max
Titanium dioxide	38.0% min to 41.0% max
Zinc oxide	16.5% min to 18.5% max
Calcium carbonate	40.5% min to 45.5% max

VEHICLE

Percent by weight	49.0% min to 52.0% max
Long oil soya alkyd resin	32.0% min to 35.0% max
Linseed oil, heat bodied	29.0% min to 32.0% max
Mineral spirits	32.0% min to 34.0% max
Linseed/tung oil, heat bodied	1.0% min to 2.0% max
Driers and rheology agents	2.5% min to 3.5% max

FINISHED PAINT TECHNICAL DATA

Viscosity - Krebs units at 77 F (25 C)	95 min to 100 max
Drying time	18 hours max
Total solids by weight	82.0% min to 84.0% max
Total solids by volume	67.0% min to 71.0% max
Weight per gallon	11.77 lb/gal (1.41 kg/L) min to 12.02 lb/gal (1.44 kg/L) max
Gloss at 59 F (15 C)	80% minimum
Clean-up solvent	Mineral spirits
Type of cure	Oxidation

517.2.6.3 Condition in Container

- (1) The ready-mixed paint as received shall not liver, skin, lump, or separate, or corrode the container, or contain hard settled pigment. Pigment shall disperse easily in the liquid portion by hand stirring to form a smooth, homogeneous paint, free from lumps, particles, or foreign material.

517.2.7 (Vacant)

517.2.8 Black Paint for Wood - Intermediate and Finish Coat

517.2.8.1 General

- (1) This subsection covers a ready-mixed, ready-to-apply black paint for exterior exposure, used for an intermediate and finish coat in a 3-coat system on marker posts or other wooden structures. This is a lead-free paint.

517.2.8.2 Composition and Properties

- (1) Furnish material conforming to the following:

PIGMENT

Percent by weight	40.0% min to 42.0% max
Lampblack	
Nepheline Syenite	

VEHICLE

Percent by weight	58.0% min to 60.0% max
Long oil alkyd resin	16.0% min to 17.0% max
Linseed oil, heat bodied	17.75% min to 18.25% max
Mineral spirits.....	23.20% min to 25.60% max
Linseed/tung oil, heat bodied	9.75% min to 10.25% max
Driers and rheology agents	1.40% min to 1.60% max
Fungicide- tetrachloroisophthalonitrile	0.70% min

FINISHED PAINT TECHNICAL DATA

Viscosity - Krebs units at 77 F (25 C).....	95 min to 100 max
Drying time.....	18 hours max
Total solids by weight.....	80.0% min to 82.0% max
Total solids by volume	68.0% min to 70.0% max
Weight per gallon	10.27 lb/gal (1.23 kg/L) min to 10.52 lb/gal (1.26 kg/L) max
Gloss at 59 F (15 C).....	80% minimum
Clean-up solvent.....	Mineral spirits
Type of cure.....	Oxidation

517.2.8.3 Condition in Container

- (1) The ready-mixed paint as received shall not liver, skin, lump, or separate, or corrode the container, or contain hard settled pigment. Pigment shall disperse easily in the liquid portion by hand stirring to form a smooth, homogeneous paint, free from lumps, particles, or foreign material.

517.2.9 Brown Stain for Wood

517.2.9.1 General

- (1) This subsection covers using a brown stain on rustic wood fences and other similar rustic materials. If the contractor cannot obtain stain conforming to these specifications because of the small quantities required, it may use an equal dark brown semi-transparent oil stain the engineer finds acceptable. This is a lead-free stain.

517.2.9.2 Composition and Properties

- (1) Furnish material conforming to the following:

PIGMENT

Percent by weight	11.0% min to 13.0% max
Black Synthetic Iron Oxide	59.0% min to 61.0% max
Dark Brown Iron Oxide.....	39.0% min to 41.0% max

VEHICLE

Percent by weight	87.0% min to 89.0% max
Linseed oil, raw	69.0% min to 71.0% max
Mineral spirits.....	25.0% min to 27.5% max
Driers and rheology agents	0.09% min to 0.12% max
Fungicide- tetrachloroisophthalonitrile	0.50% min to 0.75% max
Water repellent: poly-oxo aluminum stearate.....	2.0% min to 2.5% max

FINISHED PAINT TECHNICAL DATA

Viscosity - Krebs units at 77 F (25 C).....	45 min to 50 max
Drying time.....	48 hours max
Total solids by weight.....	76.5% min to 79.0% max
Total solids by volume	70.0% min to 72.5% max
Weight per gallon	8.18 lb/gal (0.98 kg/L) min to 8.35 lb/gal (1.00 kg/L) max
Clean-up solvent.....	Mineral spirits
Type of cure.....	Oxidation

517.3 Construction

517.3.1 Coating or Painting Metal

517.3.1.1 General

- (1) Clean and prepare the surfaces of metal parts before coating or painting.
- (2) The contractor or fabricator shall furnish and erect scaffolding, meeting the engineer's approval, to allow steel inspection before and after coating.
- (3) Use rubber rollers or other protective devices, meeting the engineer's approval, on scaffold fastenings. The contractor shall not use metal rollers or clamps and other type fastenings that mar or damage freshly coated surfaces.
- (4) For all colors, conform to the standard color samples the department furnished, or as specified.
- (5) For structural steel, including weathering steel, and miscellaneous metals that will be encased in concrete, apply only zinc-rich primer as specified in [517.3.1.7.2](#). The contractor is not required to prime or paint welded stud shear connectors and anchor bolts.

517.3.1.2 Weather Conditions

517.3.1.2.1 General

- (1) The contractor shall not apply paint if the air is misty or if conditions are otherwise unsatisfactory for the work. Do not apply paint on damp or frosted surfaces.
- (2) If coating or painting material under cover in damp or cold weather, it shall remain under cover until dry or until weather conditions allow its open exposure. The contractor shall not perform coating or painting if the metal is hot enough to cause the coating to blister and produce a porous paint film.

517.3.1.2.2 Temperature

- (1) Do not expose coated surfaces to temperatures below 35 F (2 C) until after dry enough for recoating or applying the top coat.
- (2) Do not apply zinc-rich coatings if the temperature of either the air or the steel is below 40 F (4 C).
- (3) Do not apply epoxy and urethane coatings if the temperature of either the air or the steel is below 50 F (10 C).

517.3.1.2.3 Humidity

- (1) Do not apply the epoxy coating system if the relative humidity is greater than 90 percent, or unless the steel temperature is at least 5 F (3 C) higher than the dew point temperature. Inorganic zinc-rich coatings require a minimum humidity of 50 percent during the curing period.

517.3.1.3 Surface Cleaning

517.3.1.3.1 General

- (1) Clean metal surfaces before painting and surfaces in contact because of bolting, removing rust, mill scale, dirt, oil, or grease and other foreign substances. Unless blast cleaning, neutralize all weld areas with a proper chemical and rinse with water, before cleaning.
- (2) Blast clean all non-machined surfaces of a casting before machining the casting.
- (3) Blast clean all structural steel, including steel encased in concrete.

517.3.1.3.2 Hand and Power Tool Cleaning

- (1) If the engineer allows, use metal brushes, scrapers, chisels, hammers, power tools, or other effective means to remove rust, scale, and dirt. The contractor shall not use tools that excessively scar the metal. Remove oil and grease by solvent cleaning according to SSPC-SP 1. Remove all dust or other loose material.

517.3.1.3.3 Blast Cleaning

517.3.1.3.3.1 General

- (1) This process removes mill scale, rust, dirt, and other substances from the metal surface until obtaining the specified finish. Pay special attention to cleaning the corners and re-entrant angles. Before painting, remove sand, grit, or shot adhering to the steel in corners and elsewhere. Obtain the engineer's approval of the cleaning before any painting begins. Paint the material before rust forms or as specified below.

517.3.1.3.3.2 Epoxy Coating System

- (1) Blast clean all structural steel receiving this coating to a near-white finish according to SSPC-SP 10.
- (2) Solvent clean oil and grease on surfaces receiving this coating according to SSPC-SP 1 and blast clean to a near-white finish according to SSPC-SP 10.
- (3) Remove all fins, tears, slivers, and burred or sharp edges present on any steel member, or that appears during blasting, by grinding then re-blast the area to a one to 2 mils (0.025 to 0.05 mm) surface shape.
- (4) If using abrasives for blast cleaning, use either clean dry sand, steel shot, mineral grit, or manufactured grit of a gradation that produces a uniform one to 2 mils (0.025 to 0.05 mm) profile as measured with an department-approved impregnated surface profile tape.
- (5) Remove all abrasive and paint residue from steel surfaces with a commercial grade vacuum cleaner equipped with a brush-type cleaning tool, or by double blowing. If using the double blowing method, vacuum the top surfaces of all structural steel, including top and bottom flanges; longitudinal stiffeners, splice plates, and hangers after completing the double blowing operations. Keep the steel dust free and primed within 8 hours after blast cleaning.
- (6) Protect all freshly coated surfaces from later blast cleaning operations. Brush any blast damaged primed surfaces with a non-rusting tool, or if visible rust occurs, re-blast to a near white condition. Clean the brushed or blast cleaned surfaces and re-prime within the manufacturer's recommended time.

517.3.1.3.4 Unpainted Weathering Steel

- (1) Clean and surface prepare unpainted weathering steel as specified for this steel in [506.3.31.3](#).

517.3.1.4 Paint Mixing

517.3.1.4.1 General

- (1) During use, stir the paint or coatings to keep the solids uniformly suspended. Mix the paint or coatings according to the manufacturer's directions to a smooth lump free consistency, use a high shear mixer. The contractor shall not use paddle mixers or shakers. Perform mixing, as much as practical, in the original container and continue until all the metallic powder or pigment is suspended. Equip air container paint pots with agitators.
- (2) Insure thorough dispersion of all pigment or solids that settle to the bottom of the container.

517.3.1.4.2 Zinc Rich Primers

- (1) After mixing, strain the coating through a screen with openings no larger than those for a No. 50 (300 µm) sieve. After straining, continuously agitate the mixed primer up to and during the application.

517.3.1.5 Application

517.3.1.5.1 General

- (1) Perform painting in a neat and skillful manner. Apply epoxy system coatings by spraying. Apply the coating smoothly and uniformly so no excess paint collects at any point. Provide a finished surface free of streaks, pitting, wrinkling, or other irregularities.
- (2) Use power spraying equipment that applies the coatings in a fine, even spray without adding any thinner. If applying paint with spray equipment, immediately brush it smooth, if necessary, to provide uniform coverage and to eliminate wrinkling, blistering, and air holes.
- (3) In cool weather, the contractor may warm the paint to reduce the viscosity. Heat the paint by placing the paint containers in water or on steam radiators.
- (4) Thin the paint, if necessary for proper application during cool weather, according to the manufacturer's recommendations.

517.3.1.5.2 Epoxy System

- (1) Apply all coating in a neat and skillful manner according to SSPC-PA 1, producing a uniform, even coating.
- (2) Transfer or preserve erection marks, for the field identification of members, and weight marks with a compatible paint on zinc-rich primer, or mark with soapstone on an epoxy coated surface.
- (3) Apply the coating with the spray nozzles and pressures the coating system manufacturer recommends to attain the specified film thickness. Apply coating to faying, contact, surfaces of bolted shop and field splices.

- (4) Depending on site conditions, paint may require additional time beyond that specified in the product data sheets to ensure proper drying before applying a succeeding coat. For maximum time between coats, adhere to the manufacturer's recommendations except, let no more than 60 days elapse between coats.
- (5) Determine the dry film thickness by using magnetic film thickness gauges calibrated for dry film thickness measurement according to SSPC-PA 2. The engineer will reject the coating system if minimum dry film thicknesses are less than specified.

517.3.1.6 Paint Removal

- (1) The contractor shall remove coating that does not conform to specifications or is unsatisfactory; and thoroughly clean and recoat, or correct the metal at no expense to the department.

517.3.1.7 Shop Painting

517.3.1.7.1 General

- (1) If welding structural steel, complete welding before coating the metal. If welding in the fabricating shop and later erecting by bolting, coat it after completing shop welding. Give steel surfaces welded in the field one coat of weldable primer or other department-approved protective coating after shop welding and shop fabrication.
- (2) Apply one coat to the surfaces of iron and steel castings, either milled or finished.
- (3) Upon fabrication and acceptance, coat pins and pinholes with a plastic or other department-approved coating before removing from the shop.
- (4) Remove all dry spray by vacuuming or sanding, if necessary, before shipment.
- (5) Do not load material for shipment until the final shop coating cures and inspection is complete. Mark the components, "RECOMMENDED FOR USE", only after completion and approval of loading.

517.3.1.7.2 Inorganic Zinc Rich Primer

- (1) After cleaning and approval of the entire surface receiving coating by the inspector, apply the primer in a uniform even coating bonded to the metal. Before applying the prime coat, stripe all plate edges, bolt heads, nuts, and washers with primer by either brush or spray application. Apply succeeding coats as the product data sheet shows.
- (2) The inorganic primer color shall contrast markedly with the blasted surface color. The fabricator shall submit primer color samples to the engineer for approval.
- (3) The primer coat shall have a dry film thickness on the bolted friction splices of the main members of not less than one mil (0.025 mm) or greater than 2.5 mils (0.064 mm). Apply a mist coating of primer, no greater than one mil (0.025 mm) dry film thickness, to the top of the top flange where the stud shear connectors are being welded.
- (4) On all other areas, including the outside surfaces of splice plates, ensure a minimum dry film thickness above the surface profile for the primer coat of 3 mils (0.076 mm).
- (5) Remove all bolted shop connections before blasting and coating the members. Blast and prime the parts separately then reassemble and torque the bolts fully.
- (6) If applying the coating at the required thickness in one coat produces runs, bubbles, or sags, apply the coating in 2, wet, even coats, using a 50 percent overlap with minimum dry or overspray. If excessive coating thickness produces mud cracking, remove the coating back to soundly bonded coating and recoat the area to the required thickness.
- (7) In areas lacking in primer thickness, clean the areas with power washing equipment to remove all dirt; then brush the areas with a non-rusting tool, vacuum and recoat.

517.3.1.7.3 Epoxy System (Intermediate and Protective Coats)

- (1) Mask the faying surfaces of bolted field splices and the top of the top flanges where welding the stud shear connectors during coat application. On all other areas including the outside surfaces of splice plates, make the white intermediate coat a minimum dry film thickness of 3.5 mils (0.089 mm) and the protective coat a sufficient thickness to provide a uniform color and appearance but not less than one mil (0.025 mm).

517.3.1.7.4 Handling Coated Steel

- (1) Exercise extreme care in handling the steel in the shop, during shipping, during erection, and during subsequent construction of the bridge. Insulate the steel from the binding chains by engineer-approved softeners. Use padded hooks and slings to hoist steel. Pack diaphragms and similar pieces so that no rubbing occurs during shipment that damages the coating. Store the steel at the job site on pallets or other engineer-approved supports, free of the ground or water, and stabilize to preclude falling or contact between members.

517.3.1.8 Field Painting

517.3.1.8.1 General

- (1) After completing erection, including all bolting, welding, and straightening, remove all adhering rust, scale, dirt, grease, or other foreign material as specified for cleaning surfaces in [517.3.1.3](#).
- (2) Coat surfaces inaccessible after erection with the field coats the plans show. If the retouch coating applied to the shop coat dries thoroughly and the field cleaning is satisfactorily complete, then apply the field coats as called for.
- (3) If traffic produces visible dust, control the dust, at no expense to the department, as necessary on each side of the site and take necessary precautions to keep dust and dirt off freshly painted surfaces or those awaiting paint.
- (4) Place and finish adjoining concrete work before applying the last field coat. If concrete operations damage the paint, reclean and repaint the surface.
- (5) If the precautions taken to protect the work required in [517.3.3](#) are inadequate, or the atmospheric conditions cause paint drift to become a problem, the engineer may require that the contractor discontinue spraying until taking adequate precautions or until favorable atmospheric conditions exist.

517.3.1.8.2 Field Repair of Shop Applied Epoxy Systems

- (1) The contractor shall provide a way to inspect structural steel as specified for erecting scaffolding in [517.3.1.1](#).
- (2) Make all field repairs according to the coating supplier's recommendations, supplied to the engineer by the steel fabricator. Field repairs include preparing the surface of damaged or welded areas by blast cleaning, and applying the complete 3-coat system (primer, intermediate coat, and protective coat).
- (3) Repair and recoat surfaces, that cannot be accessed after erection, before erection.
- (4) After completing erection, including all connections and any bent metal straightening, prepare the steel for repairs. Remove all adhering scale, dirt, grease, form oil or other foreign matter by appropriate means, and blast clean any rusted or uncoated areas to a near-white finish according to SSPC-SP 10. Remove all abrasive and paint residue from steel surfaces by vacuuming or double blowing, except, if double blowing, vacuum the top surfaces of all structural steel, including top and bottom flanges, splice plates and hangers afterward. Brush the coating surrounding the blasted area with a non-rusting tool, and recoat with an organic zinc rich primer produced by the manufacturer that produced the inorganic zinc rich primers used in the shop. These requirements for cleaning, mixing, and applying the coating, shall govern applying coating to repaired areas. Dry film thickness requirements for repair coats are the same as for the shop coats. Ensure proper drying conditions exist between coating applications.
- (5) Zinc coat bearings, nuts, and bolts according to the coating system manufacturer's recommendations. This procedure includes removing any residuals that might impair application, and applying a wash primer or tie coat before the shop coats.
- (6) Any temporary attachments or supports for scaffolding or forms shall not damage the coating system. Use support pads of sufficient size on the fascias where using bracing. Repair any damage that occurs from these devices by the above procedures.

517.3.2 Painting Lumber and Timber

517.3.2.1 General

- (1) If painting lumber and timber, unless the contract provides otherwise, prepare the surface; apply, protect, and dry the paint coatings; also, protect traffic and the property upon and in the vicinity of the structure; and protect all portions of the structure against disfigurement by paint or paint materials.
- (2) Clean surfaces being painted to ensure they are free from dust, dirt, or other loose or adhering foreign material.

- (3) Unless the plans, the specifications, or the contract provides otherwise, apply 3 coats of paint to all surfaces requiring paint, consisting of a prime, second and finish coat, with paint conforming to [517.2](#) for paint for wood surfaces. Ensure each coat conforms to the type of paint the plans, the specifications, or the contract designates, or as the engineer directs.

517.3.2.2 Weather Conditions

- (1) If painting wood surfaces, conform to the general weather conditions specified in [517.3.1.2](#). Do not apply paint if the air temperature is below 40 F (4 C).

517.3.2.3 Paint Mixing

- (1) Mix paint as specified in [517.3.1.4](#).

517.3.2.4 Application

- (1) Apply paint as specified in [517.3.1.5.1](#) and in the following:
- (2) If using brushes, apply paint to produce a smooth, uniform, even coating over the wood or previously applied paint and work it into all corners and crevices.
- (3) Do not apply the following coat until the previous coat dries throughout, provided, that at least 3 days elapse before applying any later paint coat.

517.3.3 Protection

- (1) The contractor shall remain responsible and shall take precautions, during all painting operations, for protecting traffic, parked vehicles, and the property upon and in the vicinity of the structure against damage by paint drift, drops, or spatters; and for protecting all portions of the structure against disfigurement by paint or equipment. The contractor shall also maintain responsibility for protecting the paint coating during the life of the contract as specified for the contractor's responsibility for work in [107.14](#).

517.3.4 Structure Repainting

- (1) The contractor shall clean and repaint existing structures or parts of existing structures as specified in the special provisions or supplemental specifications.

517.4 Measurement

- (1) The department will measure the Painting Epoxy System bid items as a single lump sum unit for each structure acceptably completed.
- (2) Unless the plans or special provisions specify otherwise, the department will not measure cleaning and painting steel grid floors, steel railing, steel piling and pile shells, drains, downspouts, and miscellaneous steel.
- (3) The department will not measure painting timber structures, including timber parts of steel structures and miscellaneous wood components furnished and erected under the contract.

517.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
517.0600	Painting Epoxy System (structure)	LS

- (2) Payment for the Painting Epoxy System bid items is full compensation for cleaning the steel, for furnishing and applying paint materials, and for field repairs.
- (3) Unless the plans or special provisions specify otherwise, payment for painting steel grid floors, steel railing, steel piling and pile shells, drains, downspouts, and miscellaneous steel, including furnishing and applying paint materials, cleaning and preparing surfaces and protecting traffic and property. This work is incidental to furnishing and erecting the various bid items for steel components.
- (4) The department will not pay for painting timber structures, including timber parts of steel structures and miscellaneous wooden objects, including the furnishing and applying of paint materials, cleaning and preparing surfaces, and protecting traffic and property. This work is incidental to furnishing and erecting the various bid items for lumber and timber components.

SECTION 518 MORTAR RUBBLE MASONRY AND DRY RUBBLE MASONRY

518.1 Description

- (1) This section describes the classes commonly known as coursed, random, and random range work and consists of roughly squared and dressed stone laid either in cement mortar or without mortar, as the contract requires.

518.2 Materials

518.2.1 General

- (1) Furnish portland cement and water as specified in [501.2](#). Unless the engineer allows an alternate, use either type I, IS, I(SM), or IP portland cement.
- (2) Furnish masonry cement conforming to ASTM C 91, type S.
- (3) Furnish hydrated lime conforming to ASTM C 207.

518.2.2 Sand for Mortar

518.2.2.1 General

- (1) Use sand conforming to [501.2.5](#), except for mortar strength and size requirements.

518.2.2.2 Mortar Strength

- (1) Sand for mortar, if subjected to the mortar strength test, shall have a tensile or compressive strength at 3 days and 7 days of not less than 85 percent of that developed by mortar of the same proportions and consistency, made of the same cement and standard Ottawa sand.

518.2.2.3 Size Requirements

- (1) Use sand uniformly graded from coarse to fine conforming to the following gradation requirements:

SIEVE SIZE	PERCENT PASSING BY WEIGHT
No. 8 (2.36 mm).....	95-100
No. 100 (150 µm).....	25 maximum
No. 200 (75 µm).....	10.0 maximum

518.2.3 Mortar

- (1) Use mortar for laying the stone and pointing composed of 3 parts sand for mortar and one part of any one of the following materials, by volume: masonry cement, a mixture of 50 percent portland cement and 50 percent masonry cement, or a mixture of 50 percent portland cement and 50 percent hydrated lime.
- (2) Use a machine to mix the mortar unless the engineer allows otherwise. Prepare machine-mixed mortar in an engineer-approved mixer and mix not less than 1 1/2 minutes. If preparing hand-mixed mortar, mix the sand and cement thoroughly in a clean, tight mortar box until uniform in color, then add clean water in a quantity that forms a stiff paste. Do not use mortar mixed longer than 30 minutes or that develops its initial set.

518.2.4 Rubble Stone

518.2.4.1 General

- (1) Use stone for rubble masonry of engineer-approved quality, sound, durable, and free from segregations, seams, cracks, and other structural defects impairing its resistance to the weather. Ensure it is free from rounded, worn, or weathered surfaces. Select stones with flat faces as nearly parallel as practical.

518.2.4.2 Size Requirements

- (1) Individual stones shall have a thickness of not less than 6 inches (150 mm) and a width of not less than 1 1/2 times the thickness. No stones, except headers, shall have a length less than 1 1/2 times their width. Stones shall decrease in thickness from bottom to top of wall.

518.2.4.3 Header Requirements

- (1) Headers shall have the same size in the interior of the wall as shown for the face and extend not less than 12 inches (300 mm) into the core or backing. They shall occupy not less than 1/5 of the face area of the wall and be evenly distributed. Headers in walls 2 feet (600 mm) or less in thickness shall extend entirely through the wall.

518.3 Construction

518.3.1 Shaping and Dressing Stone

- (1) Roughly square the stones on joints, beds, and faces. Use stone, roughly squared and pitched to line, at all angles and ends of walls. Finish all corners or angles in exterior surfaces with a chisel draft. If placing a wall stone with a sawed exterior surface, dress it a minimum of 50 percent before placing in the wall.
- (2) Perform all stone shaping or dressing before laying the stone in the wall and do not allow any dressing or hammering that might loosen the stone after placement.

518.3.2 Laying Stone

518.3.2.1 Mortar Rubble Masonry

- (1) The contractor shall not construct stone masonry in freezing weather, or if the stone contains frost, except with the engineer's written permission and subject to any conditions required.
- (2) Clean each stone surface until free of foreign matter, loose rock grains, and rock dust, then saturate with water before setting. Ensure the bed receiving the stone is clean and well moistened. Well bed all stones in freshly made mortar. Lay the masonry to line in courses roughly leveled up. For the bottom or foundation, courses use large, selected stones and lay all courses with bearing beds parallel to the natural bed of the material.
- (3) Ensure the vertical joints in each course are staggered with those in adjoining courses by at least 6 inches (150 mm). The contractor shall not locate a vertical joint directly above or below a header.
- (4) Make full mortar joints and carefully settle the stones in place before the mortar sets. The engineer will not accept spalls in the beds. Joints and beds shall average no more than one inch (25 mm) in thickness.
- (5) Always try to properly point the face joints before the mortar sets. If this is not possible, prepare the joints for pointing by raking them out to a depth of 2 inches (50 mm) before the mortar sets. Take care not to smear the stone face surfaces with the mortar forced out of the joints, or that used in pointing.
- (6) If any stone is moved or the joint broken, take up the stone, thoroughly clean the mortar from the bed and joints, and reset the stone in fresh mortar.

518.3.2.2 Dry Rubble Masonry

- (1) Lay the masonry to line and in courses roughly leveled up. For the bottom or foundation courses use large, selected stones and lay all courses with bearing beds parallel to the natural bed of the material. Use sand for the initial bedding. Face joints shall not exceed one inch (25 mm) in width.
- (2) If laying dry rubble masonry, take care that each stone bears firmly on the underlying course at not less than 3 separate points. Chink open joints, both front and rear, with spalls fitted to take firm bearing upon their top and bottom surfaces, to secure firm bearing throughout the stone length.

518.3.3 Pointing Mortar Rubble Masonry

- (1) The contractor shall not perform pointing in freezing weather or if the stone contains frost.
- (2) For joints not pointed when laying the stone, thoroughly wet the joint with clean water and fill with mortar, drive the mortar soundly into the joints and finish with an engineer-approved pointing tool. Keep the wall wet while pointing, and in hot or dry weather protect the pointed masonry from the sun and keep wet for at least 3 days after completion.
- (3) After completing the pointing and the mortar sets, clean the wall and leave it in a neat, finished condition.

518.3.4 Backfill

- (1) Backfill shall conform to [206.3.13](#).

518.4 Measurement

- (1) The department will measure Rubble Masonry Mortar and Rubble Masonry Dry by the cubic yard acceptably completed.

518.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
518.0100	Rubble Masonry Mortar	CY
518.0200	Rubble Masonry Dry	CY

- (2) Payment for Rubble Masonry Mortar and Rubble Masonry Dry is full compensation for excavating; for preparing the bed; for providing, transporting and placing all materials; and, unless the contract specifies granular backfill, for backfilling.
- (3) If granular backfill is required, the department will pay for backfill under the Backfill Granular bid item as specified in [209.5](#), or absent that bid item, as extra work.

SECTION 519 BRICK MASONRY AND CONCRETE BRICK OR BLOCK MASONRY

519.1 Description

- (1) This section describes furnishing and laying brick or concrete brick or blocks in cement mortar beds to construct manholes, inlets, or other similar drainage structures, or parts thereof.

519.2 Materials

519.2.1 Clay or Shale Brick

- (1) Conform to AASHTO M 91, grade MS.

519.2.2 Concrete Brick and Block Masonry Units

- (1) Conform to ASTM C 139 as revised here in [519.2](#).
- (2) Furnish grade A, A-FA, A-S, A-T, A-IS, or A-IP concrete as specified in [501.2](#), except for gradation and proportioning of aggregate and volume of water.
- (3) For the concrete of these units, use sized, graded, proportioned, aggregates thoroughly mixed in a batch mixer with the required proportions of cement and water, to produce a homogeneous concrete mixture of a quality that the brick or block units conform to the following requirements:
 1. Have a minimum compressive strength of 5000 pounds per square inch (34,500 kPa) (average of 3 units) at 28 days or at the time incorporating into the work if less than 28 days.
 2. The maximum water absorption shall not exceed 6 percent by weight.
 3. If steam curing the brick or block units, reduce the temperature at a rate not to exceed 40 F (22 C) per hour until within 20 F (11 C) of the outside temperature. Maintain the units at a temperature above 32 F (0 C) during the first 6 days after curing.
 4. Identify masonry units conforming to these specifications by stamping a mark on each unit, a pigment color code, or other engineer-approved markings.
 5. Use either rectangular block units, or block units curved in shape with the inside and outside surfaces curved to the required radii. For corners use blocks with a return side not less than 1/2 the length of the normal block. Curved blocks shall have inside and outside surfaces parallel.
 6. Each block shall have a length of not more than 18 inches (458 mm), a height of not more than 8 inches (204 mm). The block width or multiple block widths shall at least equal the structure width the plans show.
 7. If using blocks in the cones, or tops of manholes, or other structures, they may have any shape required to form the structure as the plans show with inside and outside joints not to exceed 3/8 inch (10 mm) in thickness. Also, design the block so that only full-length or 1/2-length units are required to lay any one course.

519.2.3 Mortar

- (1) Use mortar conforming to [518.2](#), mortar for mortar rubble masonry, except use mortar composed of 3 parts of sand for mortar, and one part of either a mixture of 50 percent portland cement and 50 percent masonry cement, or a mixture of 75 percent portland cement and 25 percent hydrated lime.

519.2.4 Curing Compound

- (1) Use a pigmented water-soluble or emulsified linseed oil membrane-forming concrete curing compound conforming to AASHTO M 148, except amend paragraph 7.1 to require the compound to display a daylight reflectance of not less than 50 percent that of magnesium oxide.

519.3 Construction

- (1) Unless the plans or contract provides otherwise, construct concrete footings, not less than 6 inches (150 mm) thick, and that cover the entire structure area under all brick or concrete block masonry. Use grade A, A-FA, A-S, A-T, A-IS, or A-IP concrete conforming to [501.2](#).
- (2) The contractor shall not construct brick or block masonry in freezing weather or if the bricks or blocks contain frost, except with the engineer's written permission and subject to the conditions the engineer requires.
- (3) Before laying, thoroughly wet all bricks or blocks and let the surface dry just enough to prevent slipping on the mortar.
- (4) The contractor shall not use broken or chipped bricks or blocks on the structure faces except if using to shape around irregular openings.

- (5) Lay the first course of bricks or blocks on a full bed of mortar. Lay all bricks or blocks in courses with full and close mortar joints. Maintain horizontal courses throughout the structure. Adjoining courses shall break joints by 1/2 the length of a brick or block, if possible. Make at least one course in every 7, for double-wall construction, all headers. If using brick for making closures, make their length not less than the width of a whole brick and, if possible, make closures with whole brick as headers.
- (6) Do not make joints more than 1/2 inch (13 mm) in thickness and use a uniform thickness throughout the structure. Finish all joints properly as the work progresses and on exposed faces strike them neatly using the "weather" joint, except if a plaster coat is required rake the joint.
- (7) Apply a plaster coat of mortar to the interior and exterior surfaces of brick, concrete brick, or block masonry, in manholes, inlets, and similar drainage structures. Make this plaster coat with the same mortar used in laying the bricks or blocks and make it not less than 1/2 inch (13 mm) thick. Before applying a plaster coat to a brick or block surface, wet them with water and let the surface dry enough to bond to the plaster coat.
- (8) As soon after applying the plaster coat to a structure as possible, apply a uniform coating of liquid membrane curing compound to the interior and exterior surfaces.

519.4 (Vacant)

519.5 Payment

- (1) The department will not pay directly for providing and laying brick masonry or concrete brick or block masonry specified under this section. This work is incidental to the various bid items using it.

SECTION 520 PIPE CULVERTS

520.1 Description

- (1) This section describes furnishing and installing reinforced concrete, or corrugated steel culvert pipe; reinforced concrete pipe, or corrugated steel pipe cattle pass, reinforced concrete apron endwalls at concrete culvert pipe installations, and steel apron endwalls at corrugated steel culvert pipe installations.
- (2) This section also includes furnishing, installing, and removing temporary culvert pipe, and cleaning existing culvert pipes.

520.2 Materials

520.2.1 General

- (1) Use materials conforming to the requirements for the class of material named and specified below.

520.2.2 Culvert Pipe

- (1) For corrugated steel pipe conform to [521.2.2](#).
- (2) For reinforced concrete pipe, conform to [522.2.2](#).
- (3) Under the Culvert Pipe Class III bid items, use either corrugated steel pipe of the thickness the contract designates or reinforced concrete pipe class III.
- (4) Under the Culvert Pipe Class IV bid items, use either corrugated steel pipe of the thickness the contract designates or reinforced concrete pipe class IV.
- (5) Under the Culvert Pipe Class V bid items, use either corrugated steel pipe of the thickness the contract designates or reinforced concrete pipe class V.
- (6) Under the Culvert Pipe Temporary bid items, use either new or used culvert pipe in a condition suitable for the purpose intended.

520.2.3 Pipe Cattle Pass

- (1) For corrugated steel pipe cattle pass conform to [521.2.3](#).
- (2) For reinforced concrete pipe cattle pass, conform to [522.2.3](#).
- (3) Under the Pipe Cattle Pass bid item, if the plans do not designate a specific type of pipe cattle pass, the contractor may use either corrugated steel pipe cattle pass, or reinforced concrete pipe cattle pass.

520.2.4 Apron Endwalls for Culvert Pipe

- (1) For steel apron endwalls, conform to [521.2.4](#).
- (2) For concrete apron endwalls, conform to [522.2.4](#).
- (3) Under the Apron Endwalls for Culvert Pipe bid items, use steel apron endwalls for corrugated steel pipe culvert installations, and use concrete apron endwalls with concrete pipe culvert installations.

520.3 Construction

520.3.1 General

- (1) Unless the engineer authorizes otherwise in writing, the contractor shall not order and deliver pipe culverts for the project until the engineer furnishes a corrected list of sizes and lengths.
- (2) Provide all temporary drainage facilities necessary to protect the work and adjacent property. Maintain temporary drainage in effective operating condition, as the engineer approves, until the permanent culvert pipe installations are operational. Remove and dispose of temporary culverts after the permanent culvert pipe installations are operational.

520.3.2 Excavating and Forming Bed for Pipe Culverts

520.3.2.1 Public Highway Culvert

- (1) If placing pipe culverts under any public highway in open trenches, either place them in an excavation in the existing ground, or in previously placed embankment compacted as specified for embankment in [section 207](#). Place and compact the embankment to at least the elevation of the top of the culvert before excavating the trench. Avoid placing embankment to an elevation exceeding 2 feet (600 mm) above the top of the culvert before placing the culvert.

- (2) Perform trenching and excavating according to 29 CFR part 1926, OSHA subpart P for excavations. If the height of the proposed embankment or earth cover above the top of the pipe exceeds 6 feet (1.8 m), excavate the trench below the top of the pipe as vertical as possible. Make the trench wide enough to allow for preparing the foundation, laying the pipe, and placing and compacting backfill as specified, except that the trench width shall not exceed the pipe's outside diameter by more than 36 inches (900 mm).
- (3) For pipe culverts, unless rock is present, the contractor may lay pipe either on a shaped, firm, earth subgrade, or on a backfilled granular foundation or bed.
- (4) If the pipe foundation is firm earth, shape the trench bottom to give full and continuous support to the pipe for at least the lower 1/10th of the outside height of circular pipes or pipe arches.
- (5) If backfilling the pipe foundation with granular material, excavate the trench to at least 6 inches (150 mm) below the elevation established for the bottom of the pipe. Backfill this depth with granular backfill as modified in [209.2.1](#) for bedding under culvert pipes, or with engineer-approved graded aggregate, that passes a one-inch (25.0 mm) sieve. Before laying the pipe on the backfilled granular material, compact the material. After laying circular pipe on this foundation, place additional granular material conforming to the above requirements under and around the pipe in layers not exceeding 6 inches (150 mm). Compact this material by ramming, tamping, or vibrating to provide full and continuous support of the pipe for at least the lower 1/6th of its outside vertical diameter.
- (6) If placing pipe arches, excavate and backfill the trench as specified above, except backfill the trench, compact, and trim to a height that fully and continuously supports the pipe arch for at least the lower 1/6th of its height.
- (7) If the existing granular foundation material for at least 6 inches (150 mm) below the pipe bottom conforms to the above requirements for granular backfill, as the engineer determines, and if no rock exists within the specified depth for granular cushion, the contractor may omit excavation and backfill beneath the pipe, and may omit shaping the bed for circular pipe.
- (8) If rock, hardpan, or fragmented material exists, excavate the trench below the pipe to an amount equal to 1/2 inch per foot (13 mm per 300 mm) of proposed embankment above the top of the pipe, but not less than 6 inches (150 mm), and backfill with material conforming to the above requirements to produce a granular cushion. Place additional granular material under and around the pipe as specified above.
- (9) Excavate recesses to receive bells if necessary.
- (10) If the plans show bedding types other than described above, conform to the plan details.

520.3.2.2 Private Entrance and Temporary Culverts

- (1) Shape the earth foundation for the pipe culverts for private entrances, and temporary installations to fit the pipe exterior with reasonable closeness for a height of at least 10 percent of the pipe's overall diameter.
- (2) If rock, hard pan, boulders, or fragmented material exist, bed the pipe on an earth, or granular cushion, compacted and shaped similarly to the above, for no less than 6 inches (150 mm) below the pipe.

520.3.3 Laying Pipe

- (1) Do not place any pipe culvert until the engineer approves the foundation. Additionally, do not place pipe culverts in cuts until completing the rough grading.
- (2) Unless the plans show otherwise, if laying 2 or more pipes next to each other, separate them by a distance equal to at least 1/2 the pipe diameter, with a minimum distance of 18 inches (450 mm). For pipes with attached apron endwalls, separate them by a distance that provides a minimum of 6 inches (150 mm) between the apron endwalls. For cast-in-place concrete or other alternate endwall installations, space pipes as the plans show.
- (3) Lay concrete pipe with bells or grooves up grade and with spigot or tongue ends fully inserted in the bells or grooves. Protect each joint against backfill infiltration by providing a full circumferential wrap of geotextile fabric extending one foot (300 mm) or more on each side of each joint and securing the wrap in place. The geotextile shall conform to [645.2.4](#), schedule A.
- (4) The contractor may use sealers conforming to [607.2](#) instead of the geotextile fabric joint wrap. Construction methods for sealing joints with these sealers shall conform to [607.3.4](#).

- (5) Furnish and install joint ties for reinforced concrete culvert pipe and reinforced concrete pipe cattle pass conforming to plan details, if required.
- (6) Lay riveted or spot-welded corrugated steel pipe so that flow is over the lap of the sheets, except for beveled end sections where the contractor may reverse the lap at the outlet end. Make field joints by joining the metal pipe sections together with a band bolted firmly in place. If elongation of the vertical diameter is specified, provide an appropriately modified prefabricated section.
- (7) Lay all pipes true to the designated line, grade, and required camber. Fit and match them to form a smooth and uniform invert.
- (8) Carefully fit the sections of pipe together to keep the size of joint openings to a minimum.
- (9) Clean sockets carefully before lowering pipes into trenches. Lower the pipes in a manner that avoids unnecessary handling in the trench.

520.3.4 Backfilling

520.3.4.1 Public Highway Culverts

- (1) Backfill permanent pipe culvert installations under any public highway with selected material from excavation that is free of large lumps, clods, or rock. If the contract or engineer specifies, backfill with granular backfill conforming to [209.2](#). If granular backfill contains 3-inch (75 mm) or larger rocks, place so that the rocks do not contact the pipe during compaction.
- (2) Place backfill in the trench over the top of the earth, granular foundation, or bed. Carefully place and thoroughly ram, tamp, or vibrate around the pipe in layers no greater than 6 inches (150 mm) deep, to the top of the pipe. Compact the entire length of each layer before placing the next layer.
- (3) Place and compact backfill material above the pipe in layers no more than 12 inches (300 mm) deep, to the top of the trench. Compact to the same degree as the material next to the trench.
- (4) Immediately after backfilling, cushion the installation as necessary by placing compacted earth embankment over the pipe for at least the trench width. Provide 2 feet (600 mm) or more cover, including backfill depth, above the pipe. Maintain this cushion during subsequent construction operations.
- (5) Place the remaining portion of the embankment, if any, above the top of the trench as specified for the adjacent embankment.
- (6) If the plans show the extent of excavation and backfill requirements for pipe culverts, conform to those plan details.

520.3.4.2 Private Entrance and Temporary Culverts

- (1) Carefully backfill private entrance and temporary culverts, then ram and tamp material to completely fill all spaces under and next to the pipe.

520.3.5 Placing Apron Endwalls

- (1) Excavate the bed for the apron endwall to the required width and grade. For metal aprons with toe plates, excavate a trench to allow placing the toe plate against the inner face of the trench if the apron is in its final position. After securing the apron to the pipe, backfill and firmly compact the trench.
- (2) Place the concrete apron endwall with its tongue or groove fully entered in the groove or tongue of the pipe.
- (3) Use the same backfill for the apron as required for the culvert pipe unless the engineer directs otherwise.

520.3.6 Cleaning Culvert Pipes

- (1) Clean the existing culvert pipes of all dirt and vegetation. Use all suitable materials removed from the culvert pipes in other areas requiring fill material within the project limits as the engineer directs. Dispose of surplus and unsuitable material as specified in [205.3.12](#).

520.3.7 Protection After Laying

- (1) Protect all culvert pipes until final acceptance of the work. The contractor shall replace any pipe damaged, either through its operations, or through its failure to protect the installation.

520.4 Measurement

- (1) The department will measure the Culvert Pipe bid items and Pipe Cattle Pass by the linear foot acceptably completed, determined by multiplying the number of units in the pipe culvert by their commercial laying length. The department will measure pipes with skewed or beveled ends by multiplying the number of regular units by their commercial laying length and adding the length of each skewed or beveled end section measured on the centerline of the structure along the flow line of the section. The department will measure elbows on the centerline and along the flow line of the elbow.
- (2) The department will measure the Apron Endwalls for Culvert Pipe bid items as each individual unit acceptably completed.
- (3) The department will measure Cleaning Culvert Pipes as each individual unit acceptably completed.

520.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
520.0100 - 0299	Culvert Pipe Class III (size)	LF
520.0300 - 0599	Culvert Pipe Class IV (size)	LF
520.0600 - 0899	Culvert Pipe Class V (size)	LF
520.1000 - 1199	Apron Endwalls for Culvert Pipe (size)	EACH
520.4000 - 4199	Culvert Pipe Temporary (size)	LF
520.5000	Pipe Cattle Pass	LF
520.7000	Cleaning Culvert Pipes	EACH

- (2) The department will make no additional compensation to the contractor for using sealers instead of geotextile fabric as allowed under [520.3.3](#).
- (3) Payment for the Culvert Pipe bid items and Pipe Cattle Pass is full compensation for providing, hauling, and placing the pipe, including bands, geotextile joint wrap if required, and joint tie if required; for all excavating, including foundation or bed, and any associated dewatering; for providing and placing granular backfill or graded aggregate for granular foundation or cushion; for backfilling unless granular backfill is specified; for maintaining temporary drainage; and for replacing damaged installations. The department will pay separately for cast-in-place concrete and alternate endwall installations under the Concrete Masonry Endwalls bid item as specified in [504.5](#) and other associated bid items.
- (4) Payment for Culvert Pipe Temporary also includes removing and disposing of the temporary culverts.
- (5) Payment for the Apron Endwalls for Culvert Pipe bid items is full compensation for providing, transporting, and installing the apron endwalls, including bands or connectors; for all excavating, including forming bed; and for backfilling unless granular backfill is specified.
- (6) If backfilling with granular backfill is specified, either in the contract as bid or subsequently by the engineer in the field, the department will pay for backfilling culvert pipe in one of the following ways:
 - If the contract contains the Backfill Granular bid item; the department will pay separately under the Backfill Granular bid item as specified in [209.5](#).
 - If the contract as bid requires granular backfill but does not contain the Backfill Granular bid item, backfilling with granular backfill is incidental to the work.
 - If the contract as bid does not require granular backfill and does not contain the Backfill Granular bid item, backfilling with granular backfill is extra work.
- (7) Payment for Cleaning Culvert Pipes is full compensation for cleaning the culvert pipe and for disposing of excess material.

SECTION 521 CORRUGATED STEEL PIPE CULVERTS

521.1 Description

- (1) This section describes furnishing and installing corrugated steel culvert pipe, corrugated steel pipe arch, steel apron endwalls for corrugated steel culvert pipe or pipe arch, and corrugated steel pipe cattle pass.

521.2 Materials

521.2.1 General

- (1) Use materials conforming to the requirements for the class of material named and specified below.

521.2.2 Corrugated Steel Pipe and Pipe Arch

- (1) Conform to AASHTO M 36 and the dimensions the plans show.

521.2.3 Corrugated Steel Pipe Cattle Pass

- (1) Use nominal 72-inch (1800 mm) diameter corrugated steel pipe conforming to [521.2.2](#) for corrugated steel pipe and pipe arch. Cast a concrete walkway in the cattle pass as the plan details show.

521.2.4 Steel Apron Endwalls

- (1) Furnish steel apron endwalls, sloped steel endwalls for cross drains, or sloped steel apron endwalls for corrugated steel culvert pipe and pipe arch as specified for corrugated steel pipe and pipe arch in [521.2.2](#) and conform to the dimensions, thickness, design, and details the plans show.

521.3 Construction

- (1) All construction methods, including ordering pipe or pipe arch, excavating trench and constructing earth or granular foundation or bed for pipe, laying pipe and backfilling for public highway and private entrance culverts and placing apron endwalls, shall conform to [520.3](#).
- (2) Protect pipe after laying as specified in [520.3.7](#).

521.4 Measurement

- (1) The department will measure the Culvert Pipe Corrugated Steel bid items, the Pipe Arch Corrugated Steel bid items, and Pipe Cattle Pass Corrugated Steel acceptably completed as specified for pipe culverts in [520.4](#).
- (2) The department will measure the Apron Endwalls bid items acceptably completed under this section as specified for apron endwalls in [520.4](#).

521.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
521.0100 - 0299	Culvert Pipe Corrugated Steel (size)	LF
521.0300 - 0499	Apron Endwalls for Culvert Pipe Sloped Cross Drains Steel (size)	EACH
521.0500 - 0699	Apron Endwalls for Pipe Arch Sloped Cross Drains Steel (size)	EACH
521.0700 - 0899	Pipe Arch Corrugated Steel (size)	LF
521.1000 - 1199	Apron Endwalls for Culvert Pipe Steel (size)	EACH
521.1200 - 1399	Apron Endwalls for Pipe Arch Steel (size)	EACH
521.1500 - 1699	Apron Endwalls for Culvert Pipe Sloped Section Steel (size)	EACH
521.1700 - 1899	Apron Endwalls for Pipe Arch Sloped Section Steel (size)	EACH
521.1900	Pipe Cattle Pass Corrugated Steel	LF

- (2) Payment for the Culvert Pipe Corrugated Steel bid items, the Pipe Arch Corrugated Steel bid items, or Pipe Cattle Pass Corrugated Steel is full compensation for providing, hauling, and placing the pipe or pipe arch, including bands and concrete walkway for pipe cattle pass; for all excavating, including foundation, or bed, and any associated dewatering; for providing and placing granular backfill or graded aggregate for granular foundation or cushion; for backfilling unless granular backfill is specified; for maintaining temporary drainage; and for replacing damaged installations. The department will pay separately for cast-in-place concrete and alternate endwall installations under the Concrete Masonry Endwalls bid item as specified in [504.5](#) and other associated bid items.

- (3) Payment for the Apron Endwalls bid items is full compensation for providing, transporting, and installing the apron endwalls, including bands or connectors.
- (4) The department will pay for backfilling with granular backfill as specified in [520.5](#).

SECTION 522 REINFORCED CONCRETE PIPE CULVERTS

522.1 Description

- (1) This section describes furnishing and installing reinforced concrete culvert pipe, reinforced concrete pipe cattle pass, or reinforced concrete apron endwalls.

522.2 Materials

522.2.1 General

- (1) Use materials conforming to the requirements for the class of material named and specified below.

522.2.2 Reinforced Concrete Pipe

- (1) Provide reinforced concrete pipe for culverts conforming to AASHTO M 170, for the class of pipe specified, except for the following requirements. The concrete mixture shall not contain less than 565 pounds of cementitious materials per cubic yard (335 kg/m³). Use one of the following combinations of cementitious materials in the concrete:
 - Portland cement only.
 - Portland blast furnace slag cement only.
 - Portland pozzolan cement only.
 - A combination of portland cement and fly ash where the fly ash is between 5 and 25 percent by weight of total cementitious material.
 - A combination of portland cement and ground granulated blast furnace slag where the slag is between 5 and 25 percent by weight of total cementitious material.

- (2) Regardless of the pipe's basis of acceptance, place reinforcement according to AASHTO M 170.

- (3) Furnish reinforced concrete pipe of the class designated.

- (4) The contractor shall not use pipe with different wall thicknesses in the same installations unless the engineer allows.

522.2.3 Reinforced Concrete Pipe Cattle Pass

- (1) Use class III, nominal 72 inch (1800 mm) diameter reinforced concrete pipe conforming to [522.2.2](#), constructed with a concrete walkway as the plans show.

522.2.4 Reinforced Concrete Apron Endwalls

- (1) Provide reinforced concrete apron endwalls for reinforced concrete pipe culverts manufactured with reinforcement and concrete conforming to the pertinent requirements for class II, wall B, reinforced concrete pipe as specified in [522.2.2](#) and as the plans show.

522.3 Construction

- (1) Perform all construction, including ordering pipe, excavating trench, and constructing earth or granular foundation or bed for pipe, laying pipe and backfilling for public highway and private entrance culverts, and placing apron endwalls as specified in [520.3](#).
- (2) Protect pipe after laying as specified in [520.3.7](#).

522.4 Measurement

- (1) The department will measure the Culvert Pipe Reinforced Concrete bid items and Pipe Cattle Pass Reinforced Concrete acceptably completed as specified for pipe culverts in [520.4](#).
- (2) The department will measure the Apron Endwalls for Culvert Pipe Reinforced Concrete bid items acceptably completed as specified for apron endwalls in [520.4](#).

522.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
522.0100 - 0299	Culvert Pipe Reinforced Concrete Class III (size)	LF
522.0300 - 0499	Culvert Pipe Reinforced Concrete Class IV (size)	LF
522.0500 - 0699	Culvert Pipe Reinforced Concrete Class V (size)	LF
522.1000 - 1199	Apron Endwalls for Culvert Pipe Reinforced Concrete (size)	EACH
522.2000	Pipe Cattle Pass Reinforced Concrete	LF

- (2) Payment for the Culvert Pipe Reinforced Concrete bid items and Pipe Cattle Pass Reinforced Concrete is full compensation for providing, hauling, and placing the pipe, including concrete walkway for pipe cattle pass; for geotextile joint wrap, and joint ties if required; for all excavating, including foundation, or bed, and any associated dewatering; for providing and placing granular backfill or graded aggregate for granular foundation or cushion; for backfilling unless granular backfill is specified; for maintaining temporary drainage; and for replacing damaged installations. The department will pay separately for cast-in-place concrete and alternate endwall installations under the Concrete Masonry Endwalls bid item as specified in [504.5](#) and other associated bid items.
- (3) Payment for the Apron Endwalls for Culvert Pipe Reinforced Concrete bid items is full payment for providing, transporting, and installing the apron endwalls; for all excavating, including forming bed; and for backfilling unless granular backfill is specified.
- (4) The department will pay for backfilling with granular backfill as specified in [520.5](#).

SECTION 523 REINFORCED CONCRETE HORIZONTAL ELLIPTICAL PIPE CULVERTS

523.1 Description

- (1) This section describes furnishing and installing reinforced concrete horizontal elliptical pipe culverts, or reinforced concrete apron endwalls.

523.2 Materials

523.2.1 General

- (1) Use materials conforming to the requirements for the class of material named and specified below.

523.2.2 Reinforced Concrete Horizontal Elliptical Pipe

- (1) Provide reinforced concrete horizontal elliptical pipe for culverts conforming to AASHTO M 207, for the class of pipe specified, except for the following requirements. The concrete mixture shall not contain less than 565 pounds of cementitious materials per cubic yard (335 kg/m³). Use one of the following combinations of cementitious materials in the concrete:
 - Portland cement only.
 - Portland blast furnace slag cement only.
 - Portland pozzolan cement only.
 - A combination of portland cement and fly ash where the fly ash is between 5 and 25 percent by weight of total cementitious material.
 - A combination of portland cement and ground granulated blast furnace slag where the slag is between 5 and 25 percent by weight of total cementitious material.

- (2) Regardless of the pipe's basis of acceptance, place reinforcement according to AASHTO M 207.

- (3) Furnish reinforced concrete horizontal elliptical pipe of the class the contract designates.

523.2.3 Reinforced Concrete Apron Endwalls

- (1) For horizontal elliptical pipe culverts use reinforced concrete apron endwalls manufactured with reinforcement and concrete conforming to the pertinent requirements for class HE-II reinforced concrete horizontal elliptical pipe as specified in [523.2.2](#) and as the plans show.

523.3 Construction

- (1) Perform all construction including ordering pipe, excavating trench, and constructing earth, or granular foundation, or bed for pipe, laying pipe and backfilling for public highway and private entrance culverts, and placing apron endwalls as specified in [520.3](#) and the following:
- (2) Excavate, shape, and backfill the pipe foundation as specified in [520.3](#) for pipe arches.
- (3) If required, install joint ties for reinforced concrete horizontal elliptical pipe conforming to the plan details.
- (4) Protect pipe after laying as specified in [520.3.7](#).

523.4 Measurement

- (1) The department will measure the Culvert Pipe Reinforced Concrete Horizontal Elliptical bid items acceptably completed as specified for pipe culverts in [520.4](#).
- (2) The department will measure the Apron Endwalls for Culvert Pipe Reinforced Concrete Horizontal Elliptical bid items acceptably completed as specified for apron endwalls in [520.4](#).

523.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
523.0100 - 0299	Culvert Pipe Reinforced Concrete Horizontal Elliptical Class HE-III (size)	LF
523.0500 - 0699	Apron Endwalls for Culvert Pipe Reinforced Concrete Horizontal Elliptical (size)	EACH

- (2) Payment for the Culvert Pipe Reinforced Concrete Horizontal Elliptical bid items is full compensation for providing, hauling, and placing the pipe, geotextile joint wrapping, and joint ties if required; for all excavating, including foundation or bed, and any associated dewatering; for providing and placing granular backfill or graded aggregate for granular foundation or cushion; for backfilling unless granular backfill is specified; for maintaining temporary drainage; and for replacing damaged installations. The department will pay separately for cast-in-place concrete and alternate endwall installations under the Concrete Masonry Endwalls bid item as specified in [504.5](#) and other associated bid items.

- (3) Payment for the Apron Endwalls for Culvert Pipe Reinforced Concrete Horizontal Elliptical bid items is full compensation for providing, transporting, and installing the apron endwalls; for all excavating, including forming bed; and for backfilling unless granular backfill is specified.
- (4) The department will pay for backfilling with granular backfill as specified in [520.5](#).

SECTION 524 SALVAGED PIPE CULVERTS

524.1 Description

- (1) This section describes excavating and removing existing culvert pipe, including pipe arch, and pipe cattle pass, and apron endwalls; and transporting, cleaning, and reinstalling at new locations the plans show or the engineer directs.

524.2 Materials

- (1) Use existing materials.

524.3 Construction

- (1) If existing pipe culverts and or apron endwalls, are designated for salvage and use in the new work, remove them from the existing location, clean, handle, transport to and install at the new location without damaging the pipe culvert. Replace any material damaged by the contractor at no expense to the department.
- (2) Install pipe culverts and apron endwalls at the new location as specified in [520.3](#).
- (3) Protect pipe after laying as specified in [520.3.7](#).

524.4 Measurement

- (1) The department will measure the Culvert Pipe Salvaged bid items, Pipe Cattle Pass Salvaged, and the Pipe Arch Salvaged Corrugated Steel bid items by the linear foot acceptably completed as specified in [520.4](#).
- (2) The department will measure acceptably completed the Apron Endwalls for Culvert Pipe Salvaged bid items as specified for apron endwalls in [520.4](#).

524.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
524.0100 - 0299	Culvert Pipe Salvaged (size)	LF
524.0600 - 0799	Apron Endwalls for Culvert Pipe Salvaged (size)	EACH
524.0800	Pipe Cattle Pass Salvaged	LF
524.0900	Pipe Arch Salvaged Corrugated Steel (rise x span)	LF

- (2) Payment for the Culvert Pipe Salvaged bid items, Pipe Cattle Pass Salvaged, and the Pipe Arch Salvaged Corrugated Steel bid items is full compensation for excavating and removing pipe from existing location, cleaning and transporting; for all excavating, including foundation or bed, and any associated dewatering; for placing pipe, including furnishing any necessary new bands; for providing and placing granular backfill or graded aggregate for granular foundation or cushion; for backfilling unless granular backfill is specified; for maintaining temporary drainage; for replacing damaged installations; and for providing and placing geotextile joint wrap if required, and joint ties if required.
- (3) Payment for the Apron Endwalls for Culvert Pipe Salvaged bid items is full compensation for excavating and removing apron endwalls from existing location; for cleaning, transporting, and installing apron endwalls, including bands or connectors; for all excavating, including forming bed; for geotextile wrap if required; for joint ties if required; and for backfilling.
- (4) The department will pay for backfilling with granular backfill as specified in [520.5](#).

SECTION 525 CORRUGATED ALUMINUM PIPE CULVERTS

525.1 Description

- (1) This section describes furnishing and installing corrugated aluminum culvert pipe.
- (2) This section also describes furnishing and installing aluminum apron endwalls or steel apron endwalls at aluminum culvert pipe installations.

525.2 Materials

525.2.1 General

- (1) Use materials conforming to the requirements for the class of material named and specified below.

525.2.2 Corrugated Aluminum Pipe

- (1) Conform to AASHTO M 196, and the dimensions the plans show.

525.2.3 Metal Apron Endwalls

- (1) Furnish metal apron endwalls for corrugated aluminum culvert pipe manufactured as specified in [525.2.2](#) for corrugated aluminum pipe or for steel apron endwalls in [521.2.4](#).

525.3 Construction

- (1) Perform all construction, including ordering pipe, excavating trench and constructing earth or granular foundation or bed for pipe, laying pipe, backfilling for public highway and private entrance culverts, and placing apron endwalls, as specified in [520.3](#).
- (2) If steel apron endwalls come attached to the corrugated aluminum pipe, install a suitable insulating material approximately 1/16 inch (2 mm) thick between the pipe and the endwall at the joint. The contractor may use one or more of the following:
 - Asphalt impregnated fabric.
 - A sheet plastic.
 - A rubber gasket.
 - Other non-degradable material of substantial strength.
- (3) Protect pipe after laying as specified in [520.3.7](#).

525.4 Measurement

- (1) The department will measure the Culvert Pipe Corrugated Aluminum bid items acceptably completed as specified for pipe culverts in [520.4](#).
- (2) The department will measure the Apron Endwalls for Culvert Pipe Aluminum bid items acceptably completed as specified for apron endwalls in [520.4](#).

525.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
525.0100 - 0299	Culvert Pipe Corrugated Aluminum (size)	LF
525.0500 - 0699	Apron Endwalls for Culvert Pipe Aluminum (size)	EACH

- (2) Payment for the Culvert Pipe Corrugated Aluminum bid items is full compensation for providing, hauling, and placing the pipe, including bands; for all excavating, including foundation or bed; and any associated dewatering; for providing and placing granular backfill or graded aggregate for granular foundation or cushion; for backfilling unless granular backfill is specified; for maintaining temporary drainage; and for replacing damaged installations. The department will pay separately for cast-in-place concrete and alternate endwall installations under the Concrete Masonry Endwalls bid item as specified in [504.5](#) and other associated bid items.
- (3) Payment for the Apron Endwalls for Culvert Pipe Aluminum bid items is full compensation for providing, transporting, and installing the apron endwalls, including bands or connectors and gaskets if required.
- (4) The department will pay for backfilling with granular backfill as specified in [520.5](#).

SECTION 526 TEMPORARY STRUCTURE

526.1 Description

- (1) This section describes the design, construction, maintenance, and removal of a temporary structure of the width specified and of the necessary waterway area.

526.2 Materials

- (1) Furnish materials conforming to part 5. The contractor may incorporate used materials in the structure if they are sound and suitable for the purpose intended.

526.3 Construction

526.3.1 Permits and Coordination

- (1) The contractor shall obtain any necessary permits as specified in [107.3](#) and shall coordinate with the issuing agency in securing the permits and complying with the terms of the permits.

526.3.2 Design

- (1) Provide plans, signed and sealed by a registered professional engineer, for all temporary structures. Submit one copy of plans to place on file. If the engineer requests, submit 2 extra copies of plans for review before ordering materials or starting construction.
- (2) The temporary structure shall span the stream and have dimensions sufficient to not constrict stream flow during use. The basic design criteria shall provide for a 5-year frequency storm with 6 inches (150 mm) of backwater. The plans shall show the minimum bridge length between abutment sheet piling, and the resultant five-year frequency high water elevation. Determine the minimum low superstructure elevation using the given high water elevation and considering local conditions. The structure shall have the minimum roadway width specified in the special provisions as measured between the faces of the railings or curbs, and at right angles to the centerline. Provide vertical abutments designed to prevent spilling fill material into the stream. If building a temporary crossing over a stream or lake subject to boating use, construct it to provide horizontal and vertical clearance, as the jurisdictional agency may require, adequate for row boats and small power boats.
- (3) Design, construct, and maintain the temporary structure so it is able to carry live loads of H 20 (MS 18) truck loading, according to the AASHTO Standard Specifications for Highway Bridges, with a 25 percent increase in the allowable stress.
- (4) Design rail and posts according to section 2.7.1 of the AASHTO Standard Specifications for Highway Bridges.
- (5) Construct rails a minimum of 2 feet, 9 inches (838 mm) high.

526.3.3 Temporary Structures

- (1) Construct temporary structures conforming to part 5.
- (2) Remove the temporary structure and approaches only when the new structure opens to traffic or the engineer authorizes.
- (3) The final cleanup of the work site includes complete removal of the temporary structure, unless the engineer directs otherwise.
- (4) All materials furnished by the contractor and incorporated in the temporary structure revert to the contractor upon removal. Dispose of as specified in [203.3.4](#).

526.4 Measurement

- (1) The department will measure the Temporary Structure bid items as a single lump sum for each structure acceptably completed.

526.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
526.0100	Temporary Structure (station)	LS

- (2) Payment for the Temporary Structure bid items is full compensation for designing, constructing, maintaining, and removing the temporary structure.

SECTION 527 STRUCTURAL PLATE PIPE AND PIPE ARCHES

527.1 Description

- (1) This section describes furnishing and installing structural plate pipe, or structural plate pipe arches.

527.2 Materials

- (1) Furnish structural plate pipe or structural plate pipe arches fabricated from zinc coated corrugated steel or aluminum alloy structural plates unless the contract specifies otherwise.
- (2) Furnish erection bolts and zinc coated corrugated steel plate conforming to AASHTO M 167.
- (3) Furnish erection bolts and aluminum alloy structural plate conforming to AASHTO M 219, except do not use aluminum bolts and nuts.
- (4) Furnish plates of the thickness the plans show or the contract specifies.
- (5) Furnish pipe arches, for a designated span width, conforming to the span and rise dimensions, and the radii of curvatures the contract designates.
- (6) Unless the contract specify otherwise, furnish structural plate pipe and pipe arches with square ends.
- (9) Repair damaged spelter coating according to AASHTO M 167.

527.3 Construction

527.3.1 Fabrication

527.3.1.1 Description of Plates

- (1) Plates shall consist of zinc coated corrugated steel or aluminum alloy structural units. Use the manufacturer's standard plate width and length for the size structure specified, and stagger the joints either circumferentially or longitudinally. Measure plate width circumferentially, or parallel to the highway centerline. Plates shall include an approximately 2 inch (50 mm) lip beyond each end crest, resulting in the given structure's actual length being approximately 4 inches (100 mm) longer than the nominal length, except if skewed or beveled. Connect the plates at longitudinal and circumferential seams by bolts.
- (2) Provide the radius of curvature the plans show.

527.3.1.2 Forming and Punching Plates

- (1) Curve each plate to the proper radius and punch the bolt holes so all plates curved to the same radius, except end plates, are interchangeable during erection.
- (2) Place bolt holes along those plate edges that form longitudinal seams in rows 2 inches (50 mm) apart, with one row in the valley and one in the crest of the corrugations. Stagger the bolt holes between crest and valley for steel plates.
- (3) Space the bolt holes along those plate edges that form the circumferential seams in the finished structure approximately 10 inches (250 mm).
- (4) Place the center of the hole no closer to the plate edge than 1 3/4 times the diameter of the bolt.
- (5) Punch the bolt holes in steel plates 3/16 inch to 9/32 inch (4.78 mm to 7.11 mm) in thickness, inclusive, before zinc coating the plates.
- (6) If the completed structure is a circular pipe, curve the plates so that if bolted together they form true circles of the required diameters.
- (7) Cut plates for forming skewed or sloped ends to produce the angle of skew or slope specified. Keep burned edges free from oxide and burrs. Place legible identification numerals on each plate part to designate its proper position in the finished structure.

527.3.2 Erection

- (1) If erecting a pipe or pipe arch structure in a trench, make the trench a sufficient width to allow thorough backfill compaction.
- (2) Bed the pipe or pipe arch in an earth foundation of uniform density, carefully shaped by a template supported at the specified grade to fit the lower plates of the structure. If rock, in either ledge or boulder form is encountered, remove it below grade and replace with granular backfill to provide a compacted cushion of a thickness of not less than 1/2 inch for every foot (13 mm for every 300 mm) of fill above the

structure, with a minimum allowable thickness of 8 inches (200 mm). If there is no stable foundation at the grade established, remove and replace all unstable soil under the structure and for a width of at least one diameter on each side of the structure with granular backfill, and compact to provide adequate support for the structure, unless the plans or special provisions specify other special construction methods.

- (3) Provide the camber the plans show or the engineer specifies in the foundation bed for a pipe or pipe arch.
- (4) After placing all the plates, tighten all bolts to a torque value between 100 foot-pounds (135.6 Nm) and 300 foot-pounds (406.7 Nm) inclusive. Tighten all bolts before starting backfilling.

527.3.3 Backfilling Pipe and Pipe Arches

- (1) If the contract contains the Backfill Structure bid item, use backfill material as specified in [210.2](#). If the contract does not contain the Backfill Structure bid item, use select material from excavation for the backfill material, free from large lumps, clods, rocks, and other objectionable substances.
- (2) After assembling the pipe or pipe arch, deposit backfill material evenly on both sides of the pipe or pipe arch in layers not greater than 6 inches (150 mm) until at least 3/4 of the depth is backfilled. Ensure thorough backfill compaction at the haunches of pipe arches and between the pipe or pipe arch and the sides of the trench, or for a distance each side of the pipe or pipe arch equal to the diameter of the pipe or pipe arch. Place the remaining 1/4 depth of fill to the top of structure equally on each side of the structure in layers not greater than 12 inches (300 mm).
- (3) If the backfill material contains 3-inch (75 mm) or larger rocks, place so that the rocks do not contact the pipe during compaction.
- (4) Under the engineer's supervision, construct an earth cover over the structure before driving heavy construction equipment over it.

527.3.4 Vertical Elongation

- (1) If the plans specify pipe of 60 inch (1500 mm) diameter or more, elongate it vertically 5 percent before placing fill. Pre-form the plates in the shop to provide the required elongation.

527.3.5 Defective Work

- (1) The department may reject work containing one or more of the following defects:

Elliptical shaping, unless specified.	Uneven laps.
Variation from a straight centerline.	Ragged edges.
Loose, unevenly lined, or spaced bolts.	Illegible brand.
Bruised, scaled, or broken spelter coating.	Dents or bends in the metal.

527.4 Measurement

- (1) The department will measure the Pipe Structural Plate and Pipe Arch Structural Plate bid items installed by the linear foot acceptably completed, measured along the centerline of the structure on the flow line, end to end of the metal.

527.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
527.0100 - 0299	Pipe Structural Plate (size)	LF
527.0300 - 0499	Pipe Arch Structural Plate (span)	LF

- (2) Payment for the Pipe Structural Plate and Pipe Arch Structural Plate bid items is full compensation for providing, handling, erecting, and installing the structure. The department will pay separately for cast-in-place concrete and alternate endwall installations under the Concrete Masonry Endwalls bid item as specified in [504.5](#) and other associated bid items.
- (3) Payment also includes backfilling except, if the contract contains the Backfill Structure bid item, the department will pay separately for backfilling under [210.5](#).
- (4) The department will pay separately for excavation under the Excavation for Structures Structural Plate Pipe or Pipe Arches bid item as specified in [206.5](#).

SECTION 528 POLYMER COATED CORRUGATED STEEL PIPE CULVERTS

528.1 Description

- (1) This section describes furnishing and installing polymer coated corrugated steel culvert pipe and pipe arch.

528.2 Materials

- (1) Furnish polymer coated corrugated steel culvert pipe and pipe arch fabricated from zinc coated sheet steel conforming to AASHTO M 218. Before fabrication, coat the sheets on both sides with polymer protective coating grade 250/250 according to AASHTO M 246. Fabricate the pipe according to AASHTO M 245 and plan details.
- (2) If the contract requires apron endwalls, use steel apron endwalls, sloped steel endwalls for cross drains, or sloped steel apron endwalls conforming to [521.2.4](#).

528.3 Construction

- (1) Construct as specified in [520.3](#) for pipe culverts.
- (2) During all work stages, including hauling, storing, and installation, avoid damage to the polymer coating. Store polymer coated pipe and pipe arch on padded supports and protect them from other objects placed against them by using padding at touch points. Use padded slings and other devices to handle and install polymer-coated objects. Repair damaged polymer coating with a polymer coating similar to and compatible with the original coating, or with a tar base material or asphaltic mastic conforming to AASHTO M 243.
- (3) Protect pipe after laying as specified in [520.3.7](#).

528.4 Measurement

- (1) The department will measure the Culvert Pipe Corrugated Steel Polymer Coated and Pipe Arch Polymer Coated Corrugated Steel bid items acceptably completed as specified in [520.4](#).

528.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
528.0100 - 0299	Culvert Pipe Corrugated Steel Polymer Coated (size)	LF
528.0300 - 0499	Pipe Arch Polymer Coated Corrugated Steel (size)	LF

- (2) Payment for the Culvert Pipe Corrugated Steel Polymer Coated and Pipe Arch Polymer Coated Corrugated Steel bid items is full compensation for providing, hauling, and placing the pipe or pipe arch, including bands; for all excavating, including foundation or bed; and any associated dewatering; for providing and placing granular backfill or graded aggregate for granular foundation or cushion; for backfilling unless granular backfill is specified; for maintaining temporary drainage; and for replacing damaged installations. The department will pay separately for cast-in-place concrete and alternate endwall installations under the Concrete Masonry Endwalls bid item as specified in [504.5](#) and other associated bid items.
- (3) The department will pay for backfilling with granular backfill as specified in [520.5](#).
- (4) The department pay separately for steel apron endwalls, sloped steel endwalls for cross drains, or sloped steel apron endwalls under the appropriate bid items provided in [section 521](#).

SECTION 529 ALUMINUM COATED CORRUGATED STEEL PIPE CULVERTS

529.1 Description

- (1) This section describes furnishing and installing aluminum coated corrugated steel culvert pipe and pipe arch.

529.2 Materials

- (1) Furnish aluminum coated corrugated steel culvert pipe and pipe arch conforming to AASHTO M 36 and the plans. Fabricate from type 2 aluminum coated sheet steel conforming to AASHTO M 274.
- (2) If the contract requires apron endwalls, use steel apron endwalls, sloped steel endwalls for cross drains, or sloped steel apron endwalls conforming to [521.2.4](#).

529.3 Construction

- (1) Construct as specified in [520.3](#) for pipe culverts.
- (2) Repair damaged aluminum coating by blast cleaning, power sanding, or wire brushing the damaged and surrounding areas. Apply zinc rich paint to the cleaned area within 24 hours and before rusting or soiling occurs, to a minimum thickness of 5 mils (0.13 mm).
- (3) Protect pipe after laying as specified in [520.3.7](#).

529.4 Measurement

- (1) The department will measure the Culvert Pipe Corrugated Steel Aluminum Coated and Pipe Arch Corrugated Steel Aluminum Coated bid items acceptably completed as specified in [520.4](#) for pipe culverts.

529.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
529.0100 - 0299	Culvert Pipe Corrugated Steel Aluminum Coated (size)	LF
529.0300 - 0499	Pipe Arch Corrugated Steel Aluminum Coated (size)	LF

- (2) Payment for the Culvert Pipe Corrugated Steel Aluminum Coated and Pipe Arch Corrugated Steel Aluminum Coated bid items is full compensation for providing, hauling, and placing the pipe or pipe arch, including bands; for all excavating, including foundation or bed; and any associated dewatering; for providing and placing granular backfill or graded aggregate for granular foundation or cushion; for backfilling unless granular backfill is specified; for maintaining temporary drainage; and for replacing damaged installations. The department will pay separately for cast-in-place concrete and alternate endwall installations under the Concrete Masonry Endwalls bid item as specified in [504.5](#) and other associated bid items.
- (3) The department will pay for backfilling with granular backfill as specified in [520.5](#).
- (4) The department pay separately for steel apron endwalls, sloped steel endwalls for cross drains, or sloped steel apron endwalls under the appropriate bid items provided in [section 521](#).

SECTION 530 CORRUGATED POLYETHYLENE PIPE CULVERTS

530.1 Description

- (1) This section describes furnishing and installing corrugated polyethylene culvert pipe.

530.2 Materials

- (1) Corrugated polyethylene culvert pipe shall conform to the plans and to AASHTO M 294 type S, having a corrugated outer wall and a smooth inner liner.
- (2) If the contract requires apron endwalls, use steel apron endwalls, sloped steel endwalls for cross drains, or sloped steel apron endwalls conforming to [521.2.4](#). Furnish them with suitable connector rods, connector bands, or other devices to fit the deeper corrugations of the polyethylene pipe and provide a tight connection.

530.3 Construction

- (1) Construct as specified in [520.3](#) for pipe culverts.
- (2) Protect pipe after laying as specified in [520.3.7](#).

530.4 Measurement

- (1) The department will measure the Culvert Pipe Corrugated Polyethylene bid items acceptably completed as specified in [520.4](#).

530.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
530.0100 - 0299	Culvert Pipe Corrugated Polyethylene (size)	LF

- (2) Payment for the Culvert Pipe Corrugated Polyethylene bid items is full compensation for providing, hauling and placing the pipe, including bands; for all excavating, including foundation or bed; and any associated dewatering; for providing and placing granular backfill or graded aggregate for granular foundation or cushion; for backfilling unless granular backfill is specified; for maintaining temporary drainage; and for replacing damaged installations. The department will pay separately for cast-in-place concrete and alternate endwall installations under the Concrete Masonry Endwalls bid item as specified in [504.5](#) and other associated bid items.
- (3) The department will pay for backfilling with granular backfill as specified in [520.5](#).
- (4) The department pay separately for steel apron endwalls, sloped steel endwalls for cross drains, or sloped steel apron endwalls under the appropriate bid items provided in [section 521](#).

PART 6 INCIDENTAL CONSTRUCTION

SECTION 601 CONCRETE CURB AND GUTTER

601.1 Description

- (1) This section describes constructing concrete curb, gutter; or curb & gutter, with, or without reinforcement.

601.2 Materials

- (1) Furnish materials conforming to the following:

Joint filler[415.2.4](#)
Concrete [section 501](#)

- (2) Provide grade A, A-2, A-FA, A-S, A-T, A-IS, or A-IP concrete conforming to [501.2](#).

601.3 Construction

601.3.1 General

- (1) The engineer will inspect concrete built under section 601 for transverse cracking as specified in [415.3.19](#) for ancillary concrete. Repair cracked concrete as the engineer directs.

601.3.2 Preparing the Foundation

- (1) Prepare the foundation by excavating to the lines, grades, and cross section the plans show and required for placing concrete. Remove and replace all soft or unsuitable material with suitable material. Compact thoroughly and finish the foundation or material underlying the proposed curb, gutter, or curb & gutter to a firm, true surface. Thoroughly moisten the foundation immediately before placing the concrete.
- (2) If the plans show, place aggregate base under curb, gutter, or curb & gutter, at the locations, thickness, and section the plans show.
- (3) Place granular subbase, if the plans show, or the special provisions specify, under curb, gutter, or curb & gutter at the locations, thickness, and section called for.
- (4) If the plans show, provide drainage for curb, gutter, or curb & gutter, foundation with underdrains, constructed as specified for underdrains in [section 612](#), where the plans show or the engineer directs.

601.3.3 Forms

- (1) Use wood or metal forms that are straight and have sufficient strength to resist springing, tipping, or other displacement during depositing and consolidating the concrete. Use surfaced planks for wood forms that are at least 2-inch (50 mm) nominal thickness stock, except for sharply curved sections. Use metal forms of engineer-approved section. Use forms that are the full depth of the required curb, gutter, or curb & gutter sections and designed to allow secure fastening. If used, construct and shape face boards, so that their lower edge conforms to the lines and radius shown by the cross section for the pertinent structure the plans show. For curves of 100-foot (30 m) radius or less, use flexible or curved forms of proper radius. Clean and oil all forms before placing concrete against them.

601.3.4 Placing Concrete

- (1) Use a machine placing, forming and consolidating curb, gutter, or curb & gutter. The resulting curb, gutter or curb & gutter shall equal or exceed that produced by forming.
- (2) Deposit, consolidate, and slip form the concrete to the required section. If not using a slip form process deposit the concrete in the forms to the proper depths, spade against the forms, consolidate thoroughly, strike off, and finish to the required section.
- (3) Unless constructed integrally with concrete pavement, securely anchor concrete curb, gutter, or curb & gutter, to adjoining concrete pavement by placing specified tie bars if and as the plans indicate.
- (4) Tie new work to existing concrete pavement using tie bars driven into the existing pavement. Use only cast-in-place tie bars in construction joints between pavement and curb, gutter, or curb & gutter placed under the contract.
- (5) Form contraction joints by sawing or forming an induced plane of weakness at least 2 inches (50 mm) deep in the curb, gutter, or curb & gutter directly opposite all construction or contraction joints in adjoining concrete pavement and at the required spacing in curb, gutter, or curb & gutter adjoining asphaltic pavement. Space all joints between 6 feet (1.8 m) and approximately 20 feet (6 m) apart, as the engineer directs.

- (6) Obtain the engineer's approval for the cut depth and the sawing equipment. Saw as soon as possible after the concrete sets sufficiently to prevent raveling during sawing, and before shrinkage cracking takes place. If this method results in random cracking, then form an induced plane of weakness.
- (7) If using separators, remove them as soon as possible after striking off, consolidating, and setting sufficiently to protect the joint width and shape. If using face forms, remove them for finishing curb face and fillets as soon as the concrete retains its shape. Remove back forms 6 hours after placing the concrete.
- (8) Construct depressions in or revisions of the curb, in curb, or curb & gutter to accommodate curb ramps and driveways at locations and as the plans show.

601.3.5 Finishing

- (1) Trowel and brush the face surfaces of the curb, or curb & gutter. Unless specified otherwise, round the back edge of curbs, the edge of the gutter next to the pavement, and edges next to expansion joints or induced contraction joints, with a 1/4 inch (6 mm) radius edger. Point any honeycombed areas occurring along forms on back of curbs or edges of gutters with mortar. Use mortar conforming to [518.2.3](#), except use only portland cement for cementing material.

601.3.6 Expansion Joints

- (1) Place expansion joints in curb, gutter, or curb & gutter constructed next to asphaltic pavement or surfacing. Locate joints everywhere that tangent and radial curb, or curb & gutter meet; on each side of every inlet 3 feet (900 mm) from the inlet, but no closer than 6 feet (1.8 m) from another joint; and on tangent sections place between 6 feet (1.8 m) and 300 feet (90 m).
- (2) If constructing curb, gutter, or curb & gutter next to, or on, portland cement concrete pavement constructed with expansion joints, then place expansion joints to match the expansion joint locations in the pavements.
- (3) Set joints at right angles to the face and top of the curb, and at right angles to the flow line and surface of gutters. Use 3/4-inch (19 mm) wide joint filler conforming to [415.2.3](#).

601.3.7 Protecting and Curing

- (1) Protect as specified for concrete pavement in [415.3.16](#).
- (2) Cure the concrete as specified for concrete pavement in [415.3.12](#).

601.3.8 Protecting in Cold Weather

- (1) Conform to [501.3.9](#) for curb, gutter, or curb & gutter placed during cold weather.

601.3.9 Integral Construction

- (1) Unless specified otherwise in the contract, the contractor may construct curb, gutter, or curb & gutter by slip forming integrally with the pavement. Extend the joints in the pavement through the integral curb, gutter, or curb & gutter. Space these joints to match the joints in the adjacent pavement.
- (2) The engineer will not require pavement reinforcing steel and load transfer dowels within the limits of the integral curb, gutter, or curb & gutter as the plans show. Construct integral curb, gutter, or curb & gutter to the section the plans show.

601.4 Measurement

- (1) The department will measure all the curb, gutter, and curb & gutter bid items under this section by the linear foot acceptably completed.
- (2) The length measured equals the distance along the base of the curb face, or along the flow line of the gutter. The department will measure continuously along a line extended across driveway and alley entrance returns or ramps.
- (3) The department will not make deductions in length for drainage structures installed in the curbing such as drop inlets, etc.
- (4) The department will measure all excavation required for and performed during this work, if covered by a bid item in the contract, as specified in the specifications. However, if the contract does not provide a bid item for excavation, it is incidental to the work.

601.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
601.0100 - 0149	Concrete Curb (type)	LF
601.0150 - 0199	Concrete Curb Integral (type)	LF
601.0200 - 0249	Concrete Gutter (inch)	LF
601.0300 - 0339	Concrete Curb & Gutter (inch)	LF
601.0340 - 0349	Concrete Curb & Gutter Integral (inch)	LF
601.0400 - 0449	Concrete Curb & Gutter (inch) (type)	LF
601.0450 - 0499	Concrete Curb & Gutter Integral (inch) (type)	LF
601.0500 - 0549	Concrete Curb & Gutter Integral (inch) Mountable (inch)	LF
601.0550 - 0599	Concrete Curb & Gutter (inch) Mountable (inch) (type)	LF

- (2) The department will adjust pay for crack repairs on concrete built under section 601 as specified in [416.5.2](#) for ancillary concrete.
- (3) Payment for all the curb, gutter, and curb & gutter bid items under this section is full compensation for all foundation excavation and preparation; all special construction required at driveway and alley entrances, or curb ramps; for providing all materials, including concrete, expansion joints, and reinforcement tie bars unless specified otherwise; for placing, finishing, protecting, and curing; for sawing joints; and for disposing of surplus excavation material, and restoring the work site. However, if the contract provides a bid item for excavation, then the department will pay for excavation required for this work as specified in the contract.

SECTION 602 CONCRETE SIDEWALKS, LOADING ZONES, SAFETY ISLANDS, AND STEPS

602.1 Description

- (1) This section describes constructing sidewalks, loading zones, safety islands, and steps including landings, of concrete, with or without reinforcement.
- (2) Unless specifically specified by the contract, sidewalks or steps built integral with and as a part of bridges or culverts are not included.

602.2 Materials

- (1) Furnish materials conforming to the following:
 - Expansion joint filler [415.2.4](#)
 - Concrete [section 501](#)
 - Reinforcement [section 505](#)
 - Electrical conduit..... [section 652](#)
- (2) Provide grade A, A-2, A-FA, A-S, A-T, A-IS, or A-IP concrete conforming to [501.2](#).

602.3 Construction

602.3.1 General

- (1) The engineer will inspect concrete built under section 602 for transverse cracking as specified in [415.3.19](#) for ancillary concrete. Repair cracked concrete as the engineer directs.

602.3.2 Sidewalks

602.3.2.1 Preparing the Foundation

- (1) Form the foundation by excavating or filling to the required elevation of the concrete bottom, or subbase bottom if specified. Tamp or compact the foundation to ensure stability. In cuts, make the foundation wide enough to allow placing forms and performing concrete placement and finishing. On embankments, construct the foundation at least 2 feet (600 mm) wider than the proposed sidewalk and extend it at least one foot (300 mm) beyond each end of the sidewalk.
- (2) Unless specified otherwise, fill all holes, ruts, and other depressions in the foundation with materials similar to those in the existing foundation. The contractor may use granular subbase or aggregate base.
- (3) If the plans show, place granular subbase or aggregate base to the thickness and section the plans show.

602.3.2.2 Forms

- (1) Furnish and use wood or metal forms, that are straight and of sufficient strength to resist springing, tipping, or other displacement during depositing and consolidating the concrete. If using wood forms, provide surfaced planks, at least 2-inch (50 mm) nominal thickness stock except for sharply curved sections. If using metal forms, ensure they are the engineer-approved section with a flat surface on top. Use forms as deep as the depth of the sidewalk. Securely stake, brace, and hold the forms firmly to the required line. Make the forms tight to prevent mortar leakage. Clean and oil all before placing concrete against them.

602.3.2.3 Placing and Finishing Concrete

- (1) Conform to [section 501](#) for the concrete. The engineer will check and approve the foundation, forms, and reinforcement if required, before placing the concrete. Place the concrete on a moist foundation, deposit it to the required depth, and consolidate sufficiently to bring the mortar to the surface, then strike-off and finish to a true and even surface. Before the mortar sets, brush or lightly broom the surface. Before performing the final surface finish, check the sidewalk surface with a 10-foot (3 m) straightedge, and correct all areas that vary 1/4 inch (6 mm) from the testing edge by adding or removing concrete while the concrete is still plastic.
- (2) If the engineer allows, the contractor may construct concrete sidewalks with suitable, engineer-approved, slip-form equipment. The contractor may omit wood floating if the slip-form equipment produces a suitable finish.
- (3) Construct curb ramps at the locations and according to the details and dimensions the plans show.

602.3.2.4 Reinforcement

- (1) If required, use reinforcement conforming to, and place it as specified on, the plans.

602.3.2.5 Joints

- (1) For sidewalks of uniform width, construct transverse joints at right angles to the sidewalk centerline, and construct longitudinal joints parallel to the centerline, unless specified otherwise. For sidewalks of variable or tapering widths, make the transverse and longitudinal joints at right angles to each other, if possible, and construct the joints as the engineer laid them out the field.
- (2) Use contraction joints to divide the sidewalk into sections.
- (3) Place 1/2-inch (13 mm) wide transverse expansion joint filler through the sidewalk at uniform intervals not greater than 96 feet (30 m) apart.
- (4) Place 1/2-inch (13 mm) wide expansion joint filler between the sidewalk and back of abutting parallel curb or gutter; and place one-inch (25 mm) wide expansion joint filler between sidewalk and buildings or other rigid structures.
- (5) Place 1/2-inch (13 mm) wide expansion joint filler between sidewalk approaches and the back of curb or gutter or edge of pavement.
- (6) No joint may deviate more than 5 degrees from perpendicular to the surface of the finished. Ensure that all joint axis do not deviate more than 1/2 inch (13 mm) from a straight line, or from the designated alignment at any point. If constructing the joints in sections, do not use offsets or concrete struts between adjacent units.
- (7) If constructing the sidewalk in partial width slabs, place transverse joints so they match the like joints in adjacent slabs. If widening existing sidewalks, place transverse joints in line with like joints in the existing sidewalk.
- (8) If possible, do not divide sidewalks into sections less than 3 feet (900 mm), or greater than 12 feet (3.7 m) in any dimension. Produce the unit areas by using metal slab division forms extending to the concrete's full depth, or by contraction joints, as specified below.
- (9) A contraction joint in sidewalk may consist of a slot or groove, at least one inch (25 mm) deep and 1/4 inch (6 mm) in wide. Form them by inserting a metal parting strip in the concrete after striking off and consolidating, and while the concrete is still plastic. As soon as the concrete retains its shape, remove the parting strip and edge-finish the joint.
- (10) The contractor may form contraction joints by cutting the concrete not less than 1/4 of the depth through with a pointed trowel or other suitable tool. Edge-finish the joint.
- (11) The contractor may saw contraction joints at least one inch (25 mm) in depth and approximately 1/8 inch (3 mm) wide in the concrete sidewalk. Perform the sawing as soon as possible after the concrete sets sufficiently to prevent raveling during sawing and before shrinkage cracking occurs.
- (12) Extend the expansion joint filler to the concrete's full depth and make the top slightly below the finished surface of the sidewalk.
- (13) Spade and compact the concrete thoroughly at all expansion joint faces to fill the voids, and finish the surface smooth and true to grade as specified above. Round the sidewalk edges along forms, un-sawed joints, and metal slab division forms with a 1/2-inch (6 mm) radius edger.
- (14) Do not seal joints.

602.3.2.6 Protecting and Curing

- (1) Cure the concrete as specified for concrete pavement in [415.3.12](#).
- (2) Protect sidewalks as specified for concrete pavement in [415.3.16](#), except that the engineer may allow the contractor to open sidewalks to pedestrian traffic after the concrete has developed sufficient strength to prevent damage to the surface.

602.3.2.7 Backfilling and Restoring the Site of the Work

- (1) If the sidewalk does not touch curb, curb & gutter, pavement, or other structures and if the concrete is cured and the forms removed, then backfill the spaces along the sides with satisfactory soil and thoroughly compact. For the backfill conform to the section the plans show. Dispose of surplus excavation and restore the work site to a neat and orderly condition.

602.3.3 Loading Zones

- (1) Construct raised loading zones in streets, if included in the contract, of concrete conforming to the requirements above, and at the locations, and as specified in the details and dimensions the plans show. If constructing loading zones on bases covered with a wearing surface, place the loading zone directly on base. If constructing loading zones on concrete pavements, place the loading zones on the finished surface. Tie loading zones to the pavement with at least four 3/4-inch (19 mm) diameter dowel or tie bars, 10 inches (250 mm) long. Use construction methods conforming to [602.3.1](#). Provide openings for traffic signals, if any, as directed.

602.3.4 Steps

- (1) If constructing steps, and landings is included in the contract, build them at the locations and as specified in the design, dimensions, and details the plans show. This work includes reinforcement and necessary excavating, backfilling, and disposing of excess excavation material.
- (2) Provide a rubbed surface finish on formed surfaces of landings, risers, and sides of steps as specified for concrete bridges in [502.3.7.3](#).
- (3) Furnish and use materials and construction methods conforming to [602.3.1](#), except as specified otherwise.

602.3.5 Safety Islands

- (1) Under the Concrete Safety Islands bid item, construct concrete safety islands conforming to the requirements above and the details and dimensions the plans show. This work includes furnishing, by the contractor, or by others, and installing all fixtures, conduits, and other materials, the detailed plans show.
- (2) Place concrete between suitable forms accurately set to conform to the design of the island, and anchor securely to preclude movement during placement and finishing operations. Unless directed otherwise, use construction methods conforming to [602.3.1](#).
- (3) Provide or construct openings in the island and in the base as the plans show for installing fixtures, posts or cables. Install all fixtures and materials at the time and in the manner designated on the plans or as the engineer directs.

602.4 Measurement

- (1) The department will measure the Concrete Sidewalk bid items, including curb ramps; Concrete Loading Zones; Concrete Steps, including landings, and Concrete Safety Islands, in square feet of surface area acceptably completed. The quantity measured shall equal the amount computed from dimensions the plans show or by the altered dimensions the engineer directs.
- (2) The measured area of steps, including landings equals the sum of the areas of the treads and landings, computed by multiplying the tread and landing width by the tread and landing length, out to out of integral wall, if any.

602.5 Payment

602.5.1 General

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
602.0400 - 0499	Concrete Sidewalk (inch)	SF
602.1000	Concrete Loading Zone	SF
602.1500	Concrete Steps	SF
602.2400	Concrete Safety Islands	SF

- (2) The department will adjust pay for crack repairs on concrete built under section 602 as specified in [416.5.2](#) for ancillary concrete.

602.5.2 Concrete Sidewalk, Loading Zone, and Steps

- (1) Payment for the Concrete Sidewalk bid items, including curb ramps; Concrete Loading Zone; or Concrete Steps, including landings; is full compensation for providing all materials, including concrete, reinforcement, and expansion joints; for excavating and preparing the foundation; backfilling and disposing of surplus material; for placing, finishing, protecting, and curing; and restoring the work site. However, if the contract provides a bid item for excavation, then the department will pay for work required and performed in constructing concrete sidewalks as specified in the contract.

- (2) When preparing the foundation the contractor may use granular subbase, or aggregate base, in this case, the department will not make additional compensation for this item.

602.5.3 Concrete Safety Islands

- (1) Payment for Concrete Safety Islands is full compensation for providing, placing, finishing and curing concrete; for providing and placing all materials, except those that the plans show as furnished by others; for handling and installing fixtures and materials that the plans show as furnished by others; and for all required excavating or openings in the base.

SECTION 603 CONCRETE BARRIER

603.1 Description

- (1) This section describes constructing permanent and temporary concrete barrier.

603.2 Materials

- (1) Furnish materials conforming to the following:
 - Concrete [section 501](#)
 - Joint filler [415.2.4](#)
 - Reinforcement [section 505](#)
- (2) Provide grade A, A-2, A-FA, A-S, A-T, A-IS, or A-IP concrete conforming to [501.2](#).
- (3) Provide epoxy coated steel reinforcement for permanent concrete barrier as specified for coated high strength bar steel reinforcement in [505.2.4](#).
- (4) Use curing compounds for permanent concrete barrier that are one of the following: a pigmented water-soluble, or an emulsified linseed oil membrane-forming concrete curing compound conforming to AASHTO M 148, except amend paragraph 7.1 to require the compound to exhibit a daylight reflectance of magnesium oxide of not less than 50 percent.
- (5) Use a curing compound for temporary concrete barrier conforming to [502.2.6.1](#) for liquid membrane-forming compounds.
- (6) The contractor may substitute used undamaged temporary precast for new unused temporary precast barrier with the engineer's written approval.

603.3 Construction

603.3.1 General

- (1) Use construction methods conforming to [section 502](#). Permanent barrier, either single-faced or double-faced, may be cast in place or precast unless the contract specifies otherwise. Transition sections shall be cast in place.

603.3.2 Permanent Barrier

603.3.2.1 Anchor Bars

- (1) The engineer will not require anchor bars if the base and barrier are cast in one pour. If casting the barrier separately from the base, install anchor dowels at the locations, spacing, and depth the plans show.
- (2) Cast the anchor bars used to anchor the barriers in the supporting surface, or secure them in drilled holes using an department-approved 2-component epoxy resin. Ensure the anchors secured with the epoxy resin develop the pullout strength the plans show.
- (3) Fill all holes with an engineer-approved, commercial non-shrink grout after installing the anchor bars.

603.3.2.2 Joints

- (1) Place expansion joints, 3/4-inch (19 mm) wide, in the barrier and footing at existing pavement expansion joints and at locations the plans show. Use filler material sized to conform to the cross section of the barrier and footing.

603.3.2.3 Curing

- (1) Cure the barrier by applying a curing compound conforming to [603.2](#) for use on permanent barriers.

603.3.2.4 Cast In Place Barriers.

603.3.2.4.1 General

- (1) Construct cast in place concrete barriers by form or engineer-approved slip form methods.
- (2) Construct barrier on horizontal curvature on a maximum 12-foot (3.7 m) chord length.
- (3) Place openings in the barrier as the plans show.

603.3.2.4.2 Straightedging

- (1) While the concrete is still plastic, test the wall surfaces, except vertical surfaces on horizontal curves, for trueness with a 10-foot (3 m) straightedge. Furnish and use an accurate 10-foot (3 m) straightedge for this purpose. Test the total surface areas of the barrier top and face by holding the straightedge in successive positions parallel to the length of the barrier. Straightedge the barrier in successive stages of not more than 1/2 the length of the straightedge.
- (2) Immediately, fill any depressions or projections that deviate more than 3/8 inch (10 mm) in 10 feet (3 m) with freshly mixed concrete or strike-off and refinish the surface.

603.3.2.4.3 Surface Finish

- (1) Broom finish all exposed slip-formed surfaces to the engineer's satisfaction. Provide a sack rubbed finish on all exposed formed surfaces as specified in [502.3.7.5](#), except on the footing.

603.3.2.4.4 Surface Smoothness Tolerance

- (1) Test the top surface, and upper front face surface except on horizontal curves, for smoothness with a 10-foot (3 m) straightedge. The engineer will evaluate vertical surfaces on horizontal curves for acceptability. The engineer will accept areas that show high spots or depressions greater than 3/8 inch (10 mm) in 10 feet (3 m), but will not accept greater than 3/4 inch (19 mm) in 10 feet (3 m).
- (2) Remove and replace areas that have high spots or depressions in excess of 3/4 inch (19 mm) in 10 feet (3 m) on the barrier top or face surfaces, at no expense to the department. Instead, the contractor may attempt to restore the barrier by grinding to a 3/4-inch (19 mm) tolerance.

603.3.2.5 Precast Barrier

- (1) Provide a sack rubbed finish on all exposed concrete surfaces as specified in [502.3.7.5](#).
- (2) The contractor may steam cure the precast barrier, provided the engineer approves the temperature and procedure; however, apply the curing compound, conforming to [603.2](#) for permanent concrete barrier, after completing steaming and after uncovering the barrier.
- (3) Install the epoxy resin anchors according to the manufacturer's instructions.

603.3.3 Temporary Barrier

603.3.3.1 General

- (1) Replace any barrier damaged during moving, installation, or use because of the contractor's negligence at no expense to the department.

603.3.3.2 Contractor Furnished and Delivered

- (1) Under the Concrete Barrier Temporary Precast Contractor Furnished & Delivered bid item, furnish and deliver precast reinforced concrete barrier conforming to the shape, dimensions, and details the plans show to worksites within the project, and remove it from those projects upon completing work.
- (2) Deliver the temporary precast barrier to a project worksite in one of the following ways:
 1. Deliver the temporary precast barrier from outside the project.
 2. Load the temporary precast barrier onto a truck from a different worksite within the project, haul it, and unload it.
- (3) Provide all exposed concrete surfaces with an ordinary surface finish as specified in [502.3.8.2](#), unless the forms provide a suitable finish, or by machine methods the engineer approves.
- (4) Cure the temporary precast barrier as specified for impervious coatings in [415.3.12.2](#).
- (5) The contractor may steam cure the precast barrier, provided the engineer approves the temperature and procedure; however, apply the curing compound, conforming to [603.2](#) for permanent concrete barrier, after done steaming and after uncovering the barrier.

603.3.3.3 Contractor Furnished and Contractor Installed

- (1) Under the Concrete Barrier Temporary Precast Contractor Furnished & Installed bid item, furnish, install, and subsequently move and reinstall precast reinforced concrete barrier. Subsequent moving and reinstalling is as identified in the contract or as the engineer directs.

- (2) Install the temporary precast barrier at the locations designated on the plans or as the engineer directs. Install as specified in plan details and to the engineer's satisfaction.

603.3.3.4 State Owned and Contractor Delivered

- (1) Under the Concrete Barrier Temporary Precast State Owned Contractor Delivered bid item, load the state owned precast reinforced concrete barrier at the designated site, deliver it to the worksites within the project, and remove and return it upon completing the work to the designated site.
- (2) Deliver the state owned temporary precast barrier to a project worksite in one of the following ways:
 1. Deliver the state owned temporary precast barrier from the state stockpile site.
 2. Load the state owned temporary precast barrier onto a truck from a different worksite within the project, haul it, and unload it.
- (3) Provide connecting pins to connect barrier sections together. The pins remain the property of the contractor after work is complete.
- (4) Replace missing or damaged reflective delineators with department-approved reflective delineators at maximum intervals of 25 feet (7.6 m) on the barrier's vertical face exposed to traffic.
- (5) Upon completing the work, return the state owned precast temporary barrier to the original state stockpile site or to a location designated in the special provisions.

603.3.3.5 State Owned and Contractor Installed

- (1) Under the Concrete Barrier Temporary Precast State Owned Contractor Installed bid item, install and subsequently move and reinstall state owned precast reinforced concrete barrier. Subsequent moving and reinstalling is as identified in the contract or as the engineer directs.
- (2) Install the temporary precast barrier at the locations designated on the plans or as the engineer directs. Install as specified in the plan details and to the engineer's satisfaction.

603.4 Measurement

- (1) The department will measure the Concrete Barrier Single-Faced, Concrete Barrier Double-Faced, and Concrete Barrier Double-Faced bid items by the linear foot acceptably completed, measured along the base of the barrier.
- (2) The department will measure the Concrete Barrier Temporary Precast Contractor Furnished & Delivered and Concrete Barrier Temporary Precast State Owned Contractor Delivered by the linear foot acceptably completed, measured as applicable to the contract, once for each worksite within the project. The department will not measure these items unless delivery includes a truck haul.
- (3) The department will measure Concrete Barrier Temporary Precast Contractor Furnished & Installed and Concrete Barrier Temporary Precast State Owned Contractor Installed by the linear foot acceptably completed. This measurement equals the length along the base of the barrier for each initial installation and for each re-installation identified in the contract or that the engineer directs.

603.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
603.0100 - 0199	Concrete Barrier Single-Faced (size)	LF
603.0200 - 0299	Concrete Barrier Double-Faced (size)	LF
603.0400 - 0499	Concrete Barrier Transition Section (size)	LF
603.0500	Concrete Barrier Temporary Precast Contractor Furnished & Delivered	LF
603.0600	Concrete Barrier Temporary Precast State Owned Contractor Delivered	LF
603.0800	Concrete Barrier Temporary Precast Contractor Furnished & Installed	LF
603.0900	Concrete Barrier Temporary Precast State Owned Contractor Installed	LF

603.5.1 Permanent Barrier

- (1) Except as specified otherwise below for cast in place barrier deficient in smoothness by more than 3/8 inch (10 mm), payment for the Concrete Barrier Single-Faced and Concrete Barrier Double-Faced bid items is full compensation for excavating and preparing the foundation; for providing all materials, including concrete, expansion joints, and reinforcement; and for placing, finishing, protecting, and curing concrete.

- (2) The department will pay for cast in place concrete barrier deficient in smoothness by more than 3/8 inch (10 mm) but less than 3/4 inch (19 mm), at 75 percent of the contract unit price. The department will administer the price adjustment under the Nonconforming Smoothness Concrete Barrier administrative item.
- (3) The department will pay for cast in place concrete barrier deficient in smoothness by more than 3/4 inch (19 mm), if satisfactorily ground and restored, at 75 percent of the contract unit price.
- (4) Payment for the Concrete Barrier Transition Section bid items is full compensation for excavating and preparing the foundation; for providing all materials, including concrete, expansion joints, and reinforcement; and for placing, finishing, protecting and curing concrete.

603.5.2 Temporary Barrier

- (1) Payment for Concrete Barrier Temporary Precast Contractor Furnished & Delivered is full compensation for providing acceptable concrete barrier including reflectors, for delivering the barrier, and for removing after completing the work.
- (2) Payment for Concrete Barrier Temporary Precast State Owned Contractor Delivered is full compensation for picking-up, hauling, and, delivering; for providing connecting pins; for providing necessary reflectors; and for removing and returning to original pickup site or another designated location after completing the work.
- (3) Payment for Concrete Barrier Temporary Precast Contractor Furnished & Installed is full compensation for installing acceptable concrete barrier.
- (4) Payment for Concrete Barrier Temporary Precast, State Owned Contractor Installed is full compensation for installing acceptable concrete barrier.

SECTION 604 SLOPE PAVING

604.1 Description

- (1) This section describes paving embankment slopes and waterways with concrete slope paving or crushed aggregate slope paving to control and prevent erosion of the slopes and waterways.

604.2 Materials

- (1) Furnish materials conforming to the following:

Water	501.3
Coarse aggregate	501.3
Concrete	section 501
Reinforcement	section 505
Expansion joint filler	415.2.4
Asphaltic materials	450.2

- (2) Furnish grade A, A-FA, A-S, A-T, A-IS, or A-IP concrete conforming to [501.2](#).
- (3) Furnish crushed stone or crushed gravel conforming to size No. 2 of coarse aggregate for concrete for the aggregate in crushed aggregate slope paving.
- (4) The requirements of [501.2.5.4.3](#) relating to soundness and wear shall not apply to crushed aggregate slope paving.
- (5) Furnish emulsified asphalt, type RS 1 or RS 2 conforming to AASHTO M 140, or type CRS 1 or CRS 2 conforming to AASHTO M 208 for the asphaltic material in crushed aggregate slope paving.

604.3 Construction

604.3.1 General

- (1) Prepare the foundation for the paving so that the finished paving surface conforms to the elevation, lines, grades and cross sections the plans show, and the engineer directs. Prepare the foundation by excavating high places and backfilling and compacting low places until it conforms to the required elevation and slope, and is uniform in density. Dispose of excess excavated material as specified for disposal of surplus or unsuitable material in [205.3.12](#), or as the engineer directs.
- (2) If the plans specify headers, cut-off walls, or similar appurtenances, construct them as the plans show.
- (3) Unless directed otherwise, place one-inch (25 mm) expansion joint filler where slope paving abuts piers, abutments, or other solid fixtures.

604.3.2 Crushed Aggregate Slope Paving

- (1) Place the crushed aggregate on the prepared foundation. Use mechanical or hand methods to shape and consolidate it to provide a stable, even, and uniform surface.
- (2) Apply the asphaltic material uniformly over the surface of the paving at a rate just sufficient to ensure penetration and binding of the particles in the upper 2 inches (50 mm) of the aggregate blanket. Avoid excessive application of asphaltic material and exercise care to prevent material run-off. Protect the surface of the adjacent structure to prevent splattering or discoloration by asphaltic material, and immediately remove all material accumulations at the foot of the slope paving.

604.3.3 Concrete Slope Paving

604.3.3.1 General

- (1) Place the concrete between forms set to grade on the prepared foundation. Make the finished concrete slab a minimum 4 inches (100 mm) thick. Ensure the concrete is a workable consistency when placed, but dry enough to retain its position when struck off. Strike-off the concrete with a straightedge supported on the forms and finish with a wood float.
- (2) Cure concrete slope paving as specified for concrete pavement in [415.3.12](#). If using the impervious coating method, provide or translucent membrane curing material as specified in [502.2.6.1](#) for curing concrete in structures. During cold weather, protect the concrete as specified in [415.3.15](#) for concrete pavement.

604.3.3.2 Waterways

- (1) Reinforce the concrete slope paving as specified in plan details. Construct joints at locations and as the plans show or as the engineer directs.

604.3.3.3 Structures

- (1) Set forms for concrete slope paving placed under structures or in areas exclusive of waterways in the direction of the slope to provide for pours 5 to 10 feet (1.5 m to 3 m) wide. Form planes of weakness or false joints in the concrete by scoring the finished surface at least 1/2 inch (13 mm) deep with an appropriate tool. Form blocks or squares approximately the width of the pour. Provide an edge-finish on joints or false joints. The contractor shall not reinforce the slope pavement unless the plans designate otherwise or as the contract provides.

604.4 Measurement

- (1) The department will measure Slope Paving Concrete or Slope Paving Crushed Aggregate by the square foot acceptably completed. The measured area equals the sum of the pavement areas, measured in the plane of the surface. The department will not measure headers or cut-off walls.

604.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
604.0400	Slope Paving Concrete	SY
604.0500	Slope Paving Crushed Aggregate	SY

- (2) Payment for Slope Paving Concrete and Slope Paving Crushed Aggregate is full compensation for all excavating and backfilling required for preparing the pavement foundation; for disposing of surplus materials; for providing all materials for concrete; for mixing, placing, finishing, curing, and protecting concrete; for providing and placing reinforcement, if required; for providing, handling, placing, and consolidating the crushed aggregate; and for providing, handling, heating, and applying the asphaltic material.

SECTION 605 DITCH CHECKS

605.1 Description

- (1) This section describes constructing masonry structures to control and prevent erosion along ditches and waterways. Make these structures of stone or concrete as specifically designated by the contract.

605.2 Materials

- (1) Furnish materials conforming to the following:

Concrete	section 501
Mortar rubble masonry	section 518
Steel reinforcement	section 505

- (2) Furnish stone for mortar rubble ditch checks conforming to [606.2](#) for stone for riprap.
- (3) Furnish grade A, A-FA, A-S, A-T, A-IS, or A-IP concrete conforming to [501.2](#).

605.3 Construction

605.3.1 General

- (1) Perform excavating and backfilling in a manner that anchors the structure into the sides and bottom of the ditch to prevent seepage and scour. Unless specified otherwise, extend each ditch check not less than 2 feet (600 mm) into the natural ground and build in a trench that gets backfilled and tamped after the completing the ditch check. Re-lay sod, if any. Dispose of surplus excavation in a neat and orderly manner to the engineer's satisfaction.
- (2) Construct the ditch checks at the approximate locations and intervals the plans show and as the engineer laid out in the field. If necessary, and if the engineer authorizes, alter the ditch check's size and shape to fit existing conditions and effectively serve the purpose intended. However, conform as close as possible to the detailed design the plans show.

605.3.2 Mortar Rubble Ditch Checks

- (1) Conform to the requirements the plans show in regards to the width of the top of the ditch check and the batter of the faces.
- (2) Construct mortar rubble ditch checks of stone masonry commonly known as coursed, random, and random range work and use fieldstone or rough, unhewn, quarry stone laid in cement mortar. Place fieldstone or the rough or unhewn quarry stone by hand, laid with close, broken joints. Select the stones so that they firmly bed against adjoining stones. Place the larger stone in the lower courses. Chink spaces between stones with spalls, or firmly ram selected small stones into place, but fill voids between large and small stones or spalls with mortar as the work progresses. Show uniform, tight spaces in the finished work. Conform to [518.3.2](#) and [518.3.3](#) for laying stone and pointing mortar rubble masonry.

605.3.3 Concrete Ditch Checks

- (1) Provide the type, amount, and placement of reinforcement in concrete ditch checks, if any, as the plans show. Adhere to the pertinent construction methods specified in [section 504](#).

605.4 Measurement

- (1) The department will measure Ditch Checks Mortar Rubble or Ditch Checks Concrete by the cubic yard acceptably completed. The measured dimensions will not exceed the dimensions the plans show or fixed by the engineer.

605.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
605.0305	Ditch Checks Mortar Rubble	CY
605.0405	Ditch Checks Concrete	CY

- (2) Payment for Ditch Checks Mortar Rubble or Ditch Checks Concrete is full compensation for providing, transporting and placing all material, including reinforcement in concrete, if required; and for excavating, backfilling, relaying sod and disposing of surplus material.

SECTION 606 RIPRAP

606.1 Description

- (1) This section describes furnishing and placing riprap.

606.2 Materials

- (1) Furnish durable field or quarry stone that is sound, hard, dense, resistant to the action of air and water, and free of seams, cracks, or other structural defects. Use stone pieces with a length and width no more than twice the thickness. Do not place material without the engineer's approval of the stone quality, size, and shape.
- (2) The department will determine the average dimension of stone pieces by averaging measurements of thickness, width, and length. Furnish stones conforming to the size requirements for the riprap grade the plans show. Size requirements are expressed as the percent of the gross in-place riprap volume occupied by stones within average dimension size ranges for each riprap grade as follows:

AVERAGE DIMENSION RANGES FOR EACH RIPRAP GRADE				FRACTION OF GROSS
LIGHT RIPRAP	MEDIUM RIPRAP	HEAVY RIPRAP	EXTRA-HEAVY RIPRAP	IN-PLACE RIPRAP VOLUME OCCUPIED
inches (mm)	inches (mm)	inches (mm)	inches (mm)	BY STONES
>16 (406)	>20 (508)	>25 (635)	>30 (762)	0%
11 - 13 (279-330)	14 - 16 (356-406)	18 - 20 (457-508)	22 - 25 (559-635)	10% - 14%
9 - 11 (229-279)	11 - 14 (279-356)	14 - 18 (356-457)	18 - 22 (457-559)	15% - 21%
4 - 9 (102-229)	5 - 11 (127-279)	6.5 - 14 (165-356)	8 - 18 (203-457)	20% - 28%
<4 (102)	<5 (127)	<6.5 (165)	<8 (203)	5% - 7%
<1 (25)	<1 (25)	<1 (25)	<1 (25)	2% or less

- (3) The contractor may substitute waste concrete slabs for stone. Furnish sound concrete, free of protruding reinforcement, and conforming to the size requirements specified for stone.
- (4) Conform to [section 518](#) for mortar rubble masonry if using mortar for grouted riprap.

606.3 Construction

606.3.1 General

- (1) Excavate and prepare the bed for the riprap. After placing the riprap, restore the surface of adjacent work and dispose of surplus material.

606.3.2 Placing Light Riprap

- (1) If laying stone above the waterline, place it by hand. Lay it with close, broken joints and firmly bed it in the slope and against the adjoining stones. Lay the stones perpendicular to the slope with ends in contact. Compact the riprap thoroughly as construction progresses. Make the finished surface even and tight. Place larger stone in lower courses. Chink spaces between stones by firmly ramming spalls into place. If placing riprap over geotextile fabric, conform to [645.3.6](#) for geotextile fabric, type R.
- (2) Unless specified otherwise, make riprap at least one foot (300 mm) thick, measured perpendicular to the slope.
- (3) Do not place riprap against, or in contact with, concrete surface before the end of the concrete's curing and protection period.

606.3.3 Placing Medium, Heavy, and Extra-Heavy Riprap

- (1) The contractor may place medium, heavy, and extra-heavy riprap by any mechanical means that produce a completed job within reasonable tolerances of the typical section the plans show. Limit handwork to the amount necessary to fill large voids or to correct segregated areas. If placing riprap over geotextile fabric, conform to [645.3.7](#) for geotextile fabric, type HR.
- (2) Unless specified otherwise, make medium riprap at least 18 inches (450 mm) thick, heavy riprap at least 24 inches (600 mm) thick, and extra-heavy riprap at least 30 inches (750 mm) thick.

606.3.4 Placing Grouted Riprap

- (1) If the plans specify using grouted riprap, lay the stone as specified above under [606.3.2](#) or [606.3.3](#). Fill the spaces between the stones with cement mortar. Use sufficient mortar to completely fill all voids, except leave the face surface of the stone exposed.
- (2) Place grout from the bottom to the top and then sweep the surface with a stiff broom. After completing the grouting, cure the surface as specified for concrete pavement in [415.3.12](#). If using the impervious coating method, provide for translucent membrane curing material as specified for curing concrete in structures in [502.2.3](#). During cold weather, protect the concrete as specified in [415.3.15](#) for concrete pavement.

606.4 Measurement

- (1) The department will measure all the bid items under this section by the cubic yard acceptably completed, measured as the volume within the limiting dimensions the contract designates or the engineer establishes in the field.

606.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
606.0100	Riprap Light	CY
606.0200	Riprap Medium	CY
606.0300	Riprap Heavy	CY
606.0400	Riprap Extra-Heavy	CY
606.0500	Grouted Riprap Light	CY
606.0600	Grouted Riprap Medium	CY
606.0700	Grouted Riprap Heavy	CY
606.0800	Grouted Riprap Extra-Heavy	CY

- (2) Payment for all the bid items under this section is full compensation for excavating, preparing the bed, providing and placing riprap, restoring adjacent work, and disposing of surplus material.
- (3) Payment for the Grouted Riprap bid items also includes placing and curing mortar.

SECTION 607 STORM SEWERS

607.1 Description

- (1) This section describes excavating required trenches or tunnels, and laying or constructing pipe storm sewers inside, then backfilling the trenches and cleaning out as necessary.

607.2 Materials

- (1) Use materials conforming to the requirements for the class of material named and specified below.
 - Composite pipe, couplings, fittings and joint materials AASHTO M 264
 - Annular rubber and plastic gaskets for flexible, watertight joints AASHTO M 198
 - External rubber gaskets, mastic, and protective film..... ASTM C 877
 - Mortar [519.2.3](#)

607.2.1 Non-reinforced Concrete Pipe

- (1) Use non-reinforced concrete pipe conforming to AASHTO M 86, for the class of pipe specified, except use a concrete mixture that contains at least 564 pounds (335 kg) of cementitious material per cubic yard (m^3) of concrete.

607.2.2 Mastic Joint Sealer

- (1) Use an department-approved cold-applied bituminous mastic joint sealer with a consistency enables application to joints with a trowel if air temperatures range from 20 F to 100 F (-7C to 38 C).

607.3 Construction

607.3.1 Excavation

607.3.1.1 General

- (1) Unless specified otherwise in the contract, or the engineer allows, perform sewer construction in open trenches and in a manner that protects pipelines or sewers from unusual stresses.
- (2) Perform trenching as specified in 29 CFR part 1926, OSHA subpart P for excavations and trenches. Make trenches wide enough to provide free working space on each side of the sewer, preferably this space shall not exceed 1/2 the nominal diameter of the pipe or size of the sewer, and never be less than 6 inches (150 mm). The required working space shall depend upon the size of the sewer and the character of the material encountered in the excavation; however, always provide sufficient space between the sewer and the sides of the trench to allow for preparing the foundation, laying the sewer, and placing and compacting the backfill as specified.
- (3) Dig the side slopes of all portions of the trench, that have an elevation less than one foot (300 mm) above the top of the pipe, as nearly vertical as possible.
- (4) If utilities and other restraints make sloping or benching of the excavation impractical, employ a shoring system conforming to OSHA Subpart P.
- (5) Excavate the trenches in reasonably close conformity with the plans and as the engineer laid out in the field. Begin trench excavation at the proposed sewer outlet and proceed toward the upper end.
- (6) Keep the trenches dewatered until the joint material sufficiently hardens.
- (7) If the contract specifies or the engineer allows, the contractor may construct sewers by tunneling or jacking instead of open trenching. Adhere to the construction details the plans show, the contract specifies or the engineer establishes.
- (8) Understand that the inlet and discharge elevations for storm sewers the plans show, are subject to revisions in order to fit field conditions, and the engineer may adjust the profile grades from those the plans show.

607.3.1.2 Rock Excavation for Storm Sewer

- (1) Classify rock excavation for storm sewer as specified for rock excavation in [205.2.3](#), except classify the necessary removal of all rock boulders with a volume of 1/2 cubic yard (0.4 m^3) or more, as rock excavation.

607.3.2 Constructing Foundation

- (1) Construct the foundation in the trench to prevent subsequent settlement and rupture of the sewer pipe.

- (2) The contractor may lay sewer pipe, except in rock, or wet conditions, on a shaped, firm earth subgrade, or on a backfilled granular foundation or bed.
- (3) If laying the pipe foundation on firm earth, shape the trench bottom to give full and continuous support to the pipe for at least the lower 1/10th of the outside vertical diameter of the pipe.
- (4) If placing the pipe foundation on backfilled granular material, excavate the trench to at least 6 inches (150 mm) below the elevation established for the bottom of the pipe. Backfill this depth with granular backfill as modified in [209.2](#) for bedding under culvert pipes, or with an engineer-approved graded aggregate, that passes a one-inch (25 mm) sieve. Compact the material before laying the pipe on the backfilled granular material.
- (5) After laying the pipe on the compacted granular foundation, place additional granular material conforming to the above requirements under and around the pipe in layers not greater than 6 inches (150 mm). Compact this material by ramming, tamping, or vibrating to provide full and continuous support to the pipe for at least the lower 1/6th of the outside vertical diameter of the pipe.
- (6) If existing granular foundation material conforms to the above requirements for granular backfill for a depth of at least 6 inches (150 mm) below the bottom of the pipe, and the engineer determines this, then omit excavating, shaping, and backfilling below the bottom of the pipe.
- (7) The contractor may use material from trench excavation conforming to [section 209](#) as foundation or bedding material.
- (8) If rock, hardpan, or fragmented material is encountered, then excavate the trench to a depth of at least 6 inches (150 mm) below the bottom of the pipe and backfill with material conforming to the above requirements to produce a granular cushion. Place additional granular material under and around the pipe as specified above.
- (9) If the sewer trench is soft, muddy, or wet and will not dry out, excavate it to at least 6 inches (150 mm) below the elevation established for the bottom of the pipe. Backfill this depth with grade 1 granular backfill as modified in [209.2](#) for bedding under culvert pipes, or with size No. 1 coarse aggregate for concrete as specified in [501.3.6.4](#) and compact thoroughly. Place this material under and around the pipe for at least the lower 1/6 of the outside vertical diameter of the pipe. Compact this material in layers not exceeding 6 inches (150 mm) as specified above.
- (10) Excavate recesses to receive bells if necessary.
- (11) If the contractor cannot obtain the proper bearing for the, excavate the unsuitable material and backfill with material conforming to the above requirements for bedding material.
- (12) If the contract details types of bedding, or required trench widths other than described above, conform to the contract details.

607.3.3 Laying Pipe Sewers

- (1) Begin laying pipes in finished trenches at the lowest point and proceed towards the upper end, also lay the pipe so the spigot or tongue ends point in the direction of flow.
- (2) Clean sockets carefully before lowering pipes into trenches. Lower and place the pipes to avoid unnecessary handling in the trench or damage to the pipe. Provide a firm bearing beneath the entire length of each section and make it substantially true to the line and grade required.
- (3) Lay all pipes with ends abutting. Take care when shoving the pipes together so the joints are properly adjusted and not overly large. Fit and match the pipes so that if set firmly in line and grade they form a sewer with a smooth and uniform invert.
- (4) After installing the pipe, seal all lift holes with suitable concrete or other engineer-approved plugs.
- (5) If it is difficult to obtain the size pipe the plans or the contract specifies, the contractor may, with the engineer's approval, furnish and install a larger size.

607.3.4 Joints

- (1) Make joints for concrete pipe with portland cement mortar, annular rubber or plastic gaskets, external rubber gaskets, or engineer-approved mastic joint sealer, as specified below, or by a combination of these types, unless the plans or contract special provisions specify the type to use.
- (2) If using portland cement or trowelable mastic joint sealer, fill the joint with cement mortar or mastic sealer and wipe the inside of the joint and finish smooth.

- (3) If using annular rubber or plastic gaskets, fit the gasket snugly into the annular space between the surfaces of the connecting parts of the pipe sections to form a flexible, watertight joint.
- (4) If using preformed mastic joint sealer, remove all sharp edges and protrusions from pipe joint surfaces and clean dust, dirt, and other foreign matter from them. The contractor may use of a primer. If using a primer, use the type recommended by the preformed seal manufacturer. After the primer dries, remove the wrapper from one side of the seal only and press the seal to the primed surface. When ready to assemble, remove the remaining wrapper and fit the pipe sections in place. Shove the pipe sections together at the required alignment. Make seals of sufficient size so that after the pipe sections are in their final position a squeeze-out of the seal is evident around the joints exterior circumference. Remove and make flush with the interior pipe wall, any extrusion of the seal inside the pipe.
- (5) Place external rubber as the manufacturer specifies and the engineer approves.
- (6) Seal joints for composite pipe with standard couplings and solvent cement or with rubber or plastic gaskets. Follow the manufacturer's directions.

607.3.5 Backfilling

- (1) Backfill all trenches and excavations immediately after completing sewer construction. Use granular backfill conforming to [section 209](#) for backfill material, except that all material shall pass a 3 inch (75 mm) sieve if placed around the pipe and to 6 inches (150 mm) above the pipe if using concrete sewer pipe, or a 1 1/2 inch (37.5 mm) sieve if using composite sewer pipe.
- (2) The contractor may use material from trench excavation conforming to [section 209](#) for granular backfill. Use in embankments if suitable, or dispose of surplus material or material unsuited for backfill as specified [205.3.12](#).
- (3) Deposit the backfill material in the trench or excavation in a manner that causes no damage to the pipe. Deposit the material in uniformly thick layers, as specified for public highway culverts in [520.3.4.1](#). Tamp or ram each layer thoroughly with proper tools that do not injure or disturb the sewer.
- (4) If puddling or water flooding is required or approved for consolidating the backfill, do not perform the first flooding until after backfilling the trench or excavation to at least 2 feet (600 mm) above the top of the pipe or sewer, and after compacting the backfill by tamping. Perform the second flooding after the previous trench filling and after compacting in uniform layers. Avoid an excess of water to prevent undue pressure on the pipe or sewer.
- (5) If using sheeting or shoring in excavation, the backfill must conform to the requirements above, carefully draw, and remove the sheeting and braces in a manner that will not disturb the completed work. Carefully refill all openings left from the pulled sheeting with engineer-approved backfill material and compact properly.
- (6) Do not walk or work on the completed pipe sewer, except as necessary to tamp or backfill, until backfilling the trench to at least 2 feet (600 mm) above the top of the pipe.
- (7) Fill the trench simultaneously on both sides of the sewer without causing injurious side pressures.

607.3.6 Clean Out

- (1) Clean all new or re-laid sewers of accumulations of silt, debris, and other foreign matter, and before acceptance, test all installations with water or other engineer-approved methods. These tests must indicate unimpeded flow.
- (2) Clean all existing sewers of silt, debris, and other foreign matter that accumulated due to the contractor's operations.

607.4 Measurement

607.4.1 Pipe Sewers

- (1) The department will measure the Storm Sewer Pipe bid items by the linear foot acceptably completed. This measurement equals the distance along the centerline of the pipe, from the pipe end at a free outlet to the center of the end catch basin, manhole, inlet, junction or other drainage structure; or from center to center of catch basins, end manholes, inlets, other drainage structures or junctions. The department will make no deduction from these measured lengths for intermediate catch basins, manholes, inlets, other drainage structures, junctions, or fittings.

607.4.2 Rock Excavation for Storm Sewer

- (1) The department will measure Storm Sewer Rock Excavation by the cubic yard acceptably completed. The department will measure this work in its original position and compute the volume, excluding boulders, by the method of average end areas.
- (2) The department will measure boulders of 1/2 cubic yard (0.4 m³) or more as specified for boulders and surface stone greater than one cubic yard in [205.5.1](#).
- (3) The department will measure this work vertically from the top of the rock to the bottom of the rock, or to an elevation 6 inches (150 mm) below the bottom of the pipe, whichever is higher, and horizontally for the required width of the trench as specified for trenching in [607.3.1.1](#). The department will not measure excavation below or beyond the specified limits.

607.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
607.0100 - 0399	Storm Sewer Pipe Non-Reinforced Concrete (class) (inch)	LF
607.0400 - 0499	Storm Sewer Pipe Composite (inch)	LF
607.5000	Storm Sewer Rock Excavation	CY

607.5.1 Pipe Sewers

- (1) Payment for the Storm Sewer Pipe bid items is full compensation for providing all materials, including all special Y's, mitered sections, elbows and connections required; for all excavating, except rock excavation; for sheeting and shoring; for forming foundation; for laying pipe; for sealing joints and making connections to new or existing fixtures; for providing granular backfill material, including bedding material; for backfilling; for removing sheeting and shoring; and for cleaning out and restoring the site of the work.
- (2) Apply contract unit prices, without adjustment, to the quantities of storm sewers constructed at elevations not greater than one foot (300 mm) above or below what the plans show. If the engineer orders the construction of pipe storm sewers or portions of pipe storm sewers at elevations greater than one foot (300 mm) above or below those the plans show, then the department will pay for this work as specified for extra work in [109.4](#).
- (3) Work performed one foot (300 mm) or less below the pipe bottom to form a satisfactory foundation as specified in [607.3.2](#) is incidental to the work. The department will pay for work required at depths greater than one foot (300 mm) below the pipe bottom as specified for extra work in [109.4](#).

607.5.2 Rock Excavation for Storm Sewer

- (1) Payment for Storm Sewer Rock Excavation is full compensation for all rock excavation and disposal. If the contract does not contain the Storm Sewer Rock Excavation bid item, the department will pay for the required excavation as specified for extra work in [109.4](#).

SECTION 608 REINFORCED CONCRETE PIPE STORM SEWERS

608.1 Description

- (1) This section describes excavating required trenches, and furnishing and laying reinforced concrete pipe of the size and class specified within them, then backfilling trenches and restoring the work site.

608.2 Materials

- (1) Furnish materials conforming to the following:

Annular rubber or plastic gaskets	607.2
Mastic joint sealer	607.2.2
External rubber gaskets.....	607.2
Mortar	519.2.3

- (2) Provide reinforced concrete pipe intended for storm sewers conforming to AASHTO M 170, for the class of pipe specified, except for the following requirements. Use a concrete mixture that contains not less than 565 pounds (335 kg/m³) of cementitious materials per cubic yard (m³). Use the one of the following combinations of cementitious materials in the concrete:
 - Portland cement only.
 - Portland blast furnace slag cement only.
 - Portland pozzolan cement only.
 - A combination of portland cement and fly ash where the fly ash is between 5 and 25 percent by weight of total cementitious material.
 - A combination of portland cement and ground granulated blast furnace slag where the slag is between 5 and 25 percent by weight of total cementitious material.

- (3) Regardless of the basis of acceptance of the pipe, conform to AASHTO M 170 for the placement of reinforcement.

608.3 Construction

- (1) Use construction methods conforming to [607.3](#).

608.4 Measurement

- (1) The department will measure the Storm Sewer Pipe Reinforced Concrete bid items by the linear foot acceptably completed. Measure along the centerline of the pipe, from the pipe end at a free outlet to the center of the end catch basin, manhole, inlet, junction or other drainage structure; or from center to center of end catch basins, manholes, inlets, other drainage structures or junctions. The department will not make deductions from these measured lengths for intermediate catch basins, manholes, inlets, other drainage structures, junctions, or fittings.

608.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
608.0100 - 0599	Storm Sewer Pipe Reinforced Concrete (class) (inch)	LF

- (2) Payment for the Storm Sewer Pipe Reinforced Concrete bid items is full compensation for providing all materials, including special Y's, mitered sections, elbows and connections; for all excavating except rock excavation; for forming foundation; for sheeting and shoring; for laying pipe; for sealing joints and making connections to new or existing fixtures; for backfilling; for providing granular backfill material, including bedding material; for removing sheeting and shoring; and for cleaning out and restoring the worksite.
- (3) Apply contract unit prices without adjustment to the quantities of storm sewer constructed at elevations less than one foot (300 mm) above or below the elevations the plans show. If the engineer orders the construction of pipe storm sewers or portions of pipe storm sewers at elevations greater one foot (300 mm) above or below the elevation the plans show, the department will pay for this work as specified for extra work in [109.4](#).
- (4) Work involved in forming a satisfactory foundation that is one foot (300 mm) or less below the bottom of the pipe as specified in [607.3.2](#) is incidental to this work. If work is required at depths greater than one foot (300 mm) below the bottom of the pipe, the department will pay for this as specified for extra work in [109.4](#).

- (5) The department will pay for rock excavation for storm sewers under the Storm Sewer Rock Excavation bid item as specified in [607.5](#).

SECTION 609 RELAID STORM SEWERS

609.1 Description

- (1) This section describes excavating required trenches, taking up and re-laying existing pipe storm sewers, backfilling trenches and restoring the work site.

609.2 Materials

- (1) Use materials conforming to the requirements for the class of material named and specified below.

Mortar	519.2.3
Annular rubber or plastic gaskets	607.2
Mastic joint sealer	607.2.2
External rubber gaskets.....	607.2

609.3 Construction

- (1) Construct as specified for storm sewers in [607.3](#), except as modified otherwise below.
- (2) If the contract provides, excavate, remove, clean, and re-lay existing pipe storm sewers the plans show, at the location the plans show, or as the engineer directs. Excavate and remove the pipe in a manner that prevents damage to it. The contractor will replace pipe damaged by its operations at no expense to the department.

609.4 Measurement

- (1) The department will measure the Relaid Storm Sewer bid items by the linear foot acceptably completed. The department will measure this length along the centerline of the pipe from the pipe end at a free outlet to the center of the end catch basin, manhole, inlet, junction or other drainage structure; or from center to center of end catch basins, manholes, inlets, other drainage structures or junctions. The department will make no deduction from these measured lengths for intermediate catch basins, manholes, inlets, other drainage structures, junctions, or fittings.

609.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
609.0100 - 0199	Relaid Storm Sewer (size)	LF

- (2) Payment for the Relaid Storm Sewer bid items is full compensation for all excavating, except rock excavation; for sheeting and shoring; backfilling; furnishing granular backfill material, including bedding material; and removing sheeting and braces; for removing, cleaning and relaying the pipe, including forming foundation; and for sealing joints and making connections to new or existing fixtures. Replace pipe designated for salvage or reuse that is made unusable through the contractor's operations at no expense to the department.
- (3) The department will apply this contract unit price without adjustment to the quantities of relaid storm sewers constructed at elevations not greater than one foot (300 mm) above or below the elevations the plans show. The department will pay for relaid storm sewers or portions of storm sewers that are constructed by engineer orders at elevations in excess of one foot (300 mm) above or below the elevations indicated on the plans as extra work.
- (4) Any work involved in forming a satisfactory foundation as described in [607.3.2](#) at depths of one foot (300 mm) or less below the bottom of the relaid pipe is incidental to the work. The department will pay for any work required at depths greater than one foot (300 mm) below the bottom of the relaid pipe as specified for extra work in [109.4](#).
- (5) The department will pay for rock excavation for storm sewers under the Storm Sewer Rock Excavation bid item as specified in [607.5](#).

SECTION 610 REINFORCED CONCRETE HORIZONTAL ELLIPTICAL PIPE STORM SEWERS

610.1 Description

- (1) This section describes excavating required trenches, furnishing and laying reinforced concrete horizontal elliptical pipe of the size and class specified within them, then backfilling trenches and restoring the work site.

610.2 Materials

- (1) Use materials conforming to the requirements for the class of material named and specified below.
 - Mastic joint sealer [607.2.2](#)
 - External rubber gaskets [607.2](#)
 - Mortar [519.2.3](#)
- (2) Provide reinforced concrete horizontal elliptical pipe for storm sewers conforming to AASHTO M 207, for the class of pipe specified, except for the following requirements. The concrete mixture shall not contain less than 565 pounds of cementitious materials per cubic yard (335 kg/m³). Use one of the following combinations of cementitious materials in the concrete:
 - Portland cement only.
 - Portland blast furnace slag cement only.
 - Portland pozzolan cement only.
 - A combination of portland cement and fly ash where the fly ash is between 5 and 25 percent by weight of total cementitious material.
 - A combination of portland cement and ground granulated blast furnace slag where the slag is between 5 and 25 percent by weight of total cementitious material.
- (3) Regardless of the basis of acceptance of the pipe, comply with AASHTO M 207 for reinforcement placement.

610.3 Construction

- (1) Use construction methods conforming to [607.3](#).

610.4 Measurement

- (1) The department will measure the Storm Sewer Pipe Reinforced Concrete Horizontal Elliptical bid items by the linear foot acceptably completed. The measured quantity equals the number of linear feet of each of the various sizes and classes of pipe measured along the centerline of the pipe. The department will measure from the pipe end at a free outlet to the center of the end catch basin, manhole, inlet, junction or other drainage structure; or from center to center of catch basins, end manholes, inlets, other drainage structures or junctions. The department will make no deduction from these measured lengths for intermediate catch basins, manholes, inlets, other drainage structures, junctions, or fittings.

610.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
610.0100 - 0199	Storm Sewer Pipe Reinforced Concrete Horizontal Elliptical (class) (h x w)	LF

- (2) Payment for the Storm Sewer Pipe Reinforced Concrete Horizontal Elliptical bid items is full compensation for providing all materials, including special Y's, mitered sections, elbows, and connections; for all excavating except rock excavation; for forming foundation, sheeting and shoring, for laying pipe and sealing joints, and making connections to new or existing fixtures; for backfilling, for providing granular backfill material, including bedding material; for removing sheeting and shoring, and for cleaning out and restoring the work site.
- (3) The department will apply this contract unit price without adjustment to the quantities of re-laid storm sewers constructed at elevations not greater than one foot (300 mm) above or below the elevations the plans show. The department will pay for re-laid storm sewers, or portions of re-laid storm sewers constructed by the engineer's orders at elevations in excess of one foot (300 mm) above or below the elevations the plans show as specified for extra work in [109.4](#).
- (4) All work involved in forming a satisfactory foundation as specified in [607.3.2](#) at depths of one foot (300 mm) or less below the bottom of the re-laid pipe is incidental to this work. The department will pay for all work required at depths greater than one foot (300 mm) below the bottom of the re-laid pipe as specified for extra work in [109.4](#).

- (5) The department will pay for rock excavation for storm sewers under the Storm Sewer Rock Excavation bid item as specified in [607.5](#).

SECTION 611 CATCH BASINS, MANHOLES, AND INLETS

611.1 Description

- (1) This section describes constructing or reconstructing catch basins, manholes, inlets and similar structures, made of concrete, brick masonry, or concrete brick or block masonry, with necessary reinforcement, metal frames, grates and lids, including required excavating and backfilling.

611.2 Materials

611.2.1 Concrete

- (1) Furnish materials conforming to the following:

Concrete	section 501
Brick masonry and concrete brick or block masonry	section 519
Mortar	519.2.3
Reinforcement.....	section 505
Structural steel	506.2.2
Miscellaneous metals.....	506.2.3

- (2) Furnish grade A, A-FA, A-S, A-T, A-IS, or A-IP concrete conforming to [501.2](#).
- (3) Use precast catch basin, manhole and inlet sections, risers, tops and bases conforming to AASHTO M 199, except use a concrete mixture that contains not less than 564 pounds (335 kg) of cementitious material per cubic yard (m) of concrete. If these units are wet cast then make them with air-entrained concrete containing 7.0 percent, +/- 1.5 percent, entrained air.
- (4) Use castings conforming to AASHTO M 105, class 30.

611.2.1 Support Assemblies

- (1) Use support assemblies, from the department's approved products list for fiber optic cable. The support assembly consists of multiple brackets, racks, and rails used to suspend the required surplus cabling and any splice enclosures for a single manhole.

611.3 Construction

611.3.1 General

- (1) Excavate and backfill as specified for excavation for structures in [section 206](#), except do not backfill concrete brick or block masonry, brick masonry, or precast concrete set on mortar beds until at least 3 days after completing the unit. Use granular backfill material for backfilling unless the engineer directs otherwise.
- (2) Construct concrete as specified in [section 501](#), and as specified for culverts and retaining walls in [section 504](#).
- (3) Construct brick masonry and concrete brick or block masonry as specified in [section 519](#).
- (4) Construct structural steel and miscellaneous metals as specified for steel bridges in [section 506](#).
- (5) Cure the concrete by one of the methods specified in [502.3.9](#) for curing concrete in substructure units.
- (6) The inlet and discharge elevations for catch basins, manholes and inlets as indicated on the plans are subject to all revisions necessary to fit field conditions. The engineer may increase or decrease the depth of catch basins, manholes, or inlets in order to adjust their inlet or discharge elevations.
- (7) Place precast reinforced bases on a 6-inch (150 mm) or thicker bed of uniformly compacted granular material conforming to [section 209](#).

611.3.2 Connections

- (1) Make inlet and outlet sewer pipe, sewers and conduit for connections with structures the same size, type and class as the sewer pipe, sewers and conduit to which connections are made and that they conform to the same pertinent requirements.
- (2) For pipe placed in masonry for inlet or outlet connections, make it flush on the inside of the structure wall and extend the pipe through the walls and beyond the outside surfaces of the walls a sufficient distance to allow for connections with conduits or sewers. Carefully construct the masonry around them to prevent leakage around their outer surfaces.

- (3) For fiber optic installations, permanently attach support assemblies to the manhole wall and mortar seal around all entering conduits.

611.3.3 Frames, Grates, and Lids

- (1) Set all frames on full mortar beds except as specified for placing concrete in [415.3.7](#), or secure otherwise as the plans show. Fit or secure the grates and lids to the frames to eliminate rocking or chattering.
- (2) Set the frames, grates, and lids accurately so the complete installation is at the correct elevation required to fit the adjoining surfaces. If installed in concrete surfaces, set the frames or castings, and grout as necessary, as specified in [415.3.7](#). Make sure the grates or lids are not in place while striking off and finishing the adjoining concrete.
- (3) Set frames located in pavement areas so that they comply with the surface requirements specified in [450.3.2.9](#). Place a 6-foot (1.8 m) straightedge over the centerline of each frame parallel to the direction of traffic at the completion of the paving. Make a measurement at each side of the frame, average the 2 measurements. If this average is greater than 5/8 inch (16 mm), reset the frame to the correct plane and elevation. If this average is 5/8 inch (16 mm) or less but greater than 3/8 inch (10 mm), the department will allow the frame to remain in place.
- (4) If the frame is higher than the adjacent pavement, then make the 2 measurements at each end of the straightedge and average them 2.

611.3.4 Steps

- (1) Install steps in all manholes as the plans show.

611.3.5 Reconstructing Catch Basins, Manholes, and Inlets

- (1) If the plans show and the contract provides, reconstruct existing catch basins, manholes and inlets to the required lines and elevations the plans show, including the salvaging and resetting of existing covers, unless the contract provides for new covers or other salvaged covers.
- (2) Use construction methods conforming to the requirements set forth above for the classes of work involved.

611.3.6 Covers for Catch Basins, Manholes, and Inlets

611.3.6.1 General

- (1) Place the frames on full mortar beds, except as specified in [415.3.7](#), and adjust them to bring the complete installation to the required elevation.
- (2) Under the Manhole Covers Type M-Communications and Manhole Covers Type Q-Communications bid items, use covers stamped with "WISDOT COMMUNICATIONS" as the plans show.

611.3.6.2 New Covers

- (1) If the plans show, the contract provides, or the engineer directs, furnish and install new covers, including frames, grates or lids, as the plans show, on both new and existing structures.

611.3.6.3 Salvaged Covers

- (1) If the plans show and the contract provides, remove, handle, store and reinstall existing covers in a manner that prevents damaging the covers. If the contractor damages covers through its own operations then the contractor shall replace them at no expense to the department.
- (2) Use construction methods conforming to the requirements above for these installations.

611.3.7 Adjusting Catch Basin, Manhole, and Inlet Covers

- (1) Unless the contract provides otherwise, adjust existing covers, including frames and grates or lids, to the required elevation. Remove the existing fixture, adjust the top of the existing structure, and reinstall the fixture. Support the fixture on a collar of concrete, brick masonry, concrete brick or block masonry, a precast concrete grade ring, or a grade ring from the department's approved product list, constructed to hold the covers firmly in place.
- (2) Instead of adjusting the covers as specified above, the contractor may adjust the lids of covers on resurfacing projects, if the engineer allows, by using engineer-approved adjustment castings designed for the purpose.

- (3) A vertical change exceeding one foot (300 mm) in the elevation of a cover, or requiring removal of masonry beyond the shimming or grade adjustment device, is a reconstruction and the contractor must comply with [section 611](#) for reconstruction of catch basins, manholes and inlets.

611.3.8 Clean Out

- (1) The contractor shall clean out all soil, debris, or other accumulated matter from all catch basins, manholes, inlets, or similar structures constructed or reconstructed under the contract before the engineer will accept the work. Remove all materials in all of these structures deposited or lodged due to the contractor's operations.

611.4 Measurement

- (1) The department will measure all the bid items under this section as each individual unit acceptably completed.

611.5 Payment

611.5.1 General

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
611.0100 - 0199	Catch Basins (type)	EACH
611.0200 - 0299	Manholes (type)	EACH
611.0300 - 0399	Inlets (type)	EACH
611.0410	Reconstructing Catch Basins	EACH
611.0420	Reconstructing Manholes	EACH
611.0430	Reconstructing Inlets	EACH
611.0500 - 0599	Manhole Covers (type)	EACH
611.0600 - 0699	Inlet Covers (type)	EACH
611.8105	Adjusting Catch Basin Covers	EACH
611.8110	Adjusting Manhole Covers	EACH
611.8115	Adjusting Inlet Covers	EACH
611.9705	Salvaged Manhole Covers	EACH
611.9710	Salvaged Inlet Covers	EACH

- (2) Granular backfill material required for backfilling is incidental to the work.

611.5.2 Catch Basins, Manholes, and Inlets

- (1) Payment for the Catch Basins, Manholes, and Inlets bid items is full compensation for providing all materials, including all masonry, conduit and sewer connections, steps and other fittings; for all excavating, backfilling, disposing of surplus material, and for cleaning out and restoring the work site; except that the department will pay for covers, including frames, grates and lids separately.
- (2) The department will apply contract unit prices without adjustment to the quantities of all catch basins, manholes, or inlets constructed to depths not greater than one foot (300 mm) above or below the elevations, the plans show. Catch basins, manholes, or inlets that the engineer orders constructed to depths greater than one foot (300 mm) above or below the elevations the plans show as specified for extra work in [109.4](#).

611.5.3 Reconstructing Catch Basins, Manholes, and Inlets

- (1) Payment for Reconstructing Catch Basins, Reconstructing Manholes, and Reconstructing Inlets is full compensation for providing all required materials, including masonry and fittings; for salvaging and reinstalling existing covers, including frames, grates or lids; for all necessary excavation, backfilling, disposing of surplus material, and for cleaning out and restoring the work site.

611.5.4 Manhole Covers and Inlet Covers

- (1) Payment for the Manhole Covers and Inlet Covers bid items is full compensation for removing and salvaging the existing covers; and for providing new covers, including frames, grates or lids, and all other required materials and for installing and adjusting each cover. Old covers removed remain the property of the municipality.

611.5.5 Adjusting Catch Basin, Manhole, and Inlet Covers

- (1) Payment for Adjusting Catch Basin Covers, Adjusting Manhole Covers, and Adjusting Inlet Covers is full compensation for providing all required materials, exclusive of frames, grates or lids available and designated for adjusting; and for removing, reinstalling and adjusting the covers. The contractor shall replace all covers to be adjusted and that are unusable due to the contractor's operations, at no expense to the department.

611.5.6 Salvaged Manhole Covers and Inlet Covers

- (1) Payment for Salvaged Manhole Covers and Salvaged Inlet Covers is full compensation for removing the existing cover including frames, grates or lids; for cleaning, transporting and storing; for installing and adjusting; and for providing all other required materials.

SECTION 612 UNDERDRAINS

612.1 Description

- (1) This section describes providing necessary subsurface drainage by constructing trenches, placing designated pipes or drainage devices within, if required, and backfilling the trenches with granular or other engineer-approved backfill material.

612.2 Materials

612.2.1 General

- (1) Furnish and use materials conforming to the following requirements. Furnish all pipe as perforated unless the plans show or the special provisions specify unperforated pipe.
- (2) The contractor may furnish, unless the contract specifies otherwise, one of the materials specified in [612.2](#), except drain tile under the Pipe Underdrain or Pipe Underdrain Unperforated bid items.

612.2.2 Corrugated Steel Pipe

- (1) Provide corrugated steel pipe for underdrains conforming to type III culverts of AASHTO M 36. Provide perforations conforming to class I. Use sheets not less than 0.052 inch (1.32 mm) thick for 6-inch (150 mm) underdrains or 0.064 inch (1.62 mm) for 8 inch to 21 inch (200 to 525 mm), inclusive, diameter underdrains.
- (2) If installing the pipes underground, the contractor may furnish coupling bands that have engineer-approved wedging, clamping, or other fasteners, instead of bolts.

612.2.3 Drain Tile

- (1) Unless the plans or contract provide otherwise, use drain tile for underdrains that is type II, extra-quality drain tile, and conforms to AASHTO M 179, or use extra-quality concrete drain tile, and conform to AASHTO M 178.

612.2.4 Corrugated Aluminum Alloy Pipe

- (1) Use corrugated aluminum alloy pipe for underdrains conforming to type III pipes of AASHTO M 196. Use a sheet not less than 0.060 inch (1.52 mm) thick. Provide perforations conforming to the requirements for class I.
- (2) If installing the pipes underground, the contractor may furnish coupling bands that have engineer-approved wedging, clamping, or other fasteners, instead of bolts.

612.2.5 Corrugated Polyethylene Drainage Pipe

- (1) Use corrugated polyethylene drainage pipe for underdrains conforming to AASHTO M 252, type CP and AASHTO M 294, type CP with class 2 perforations.

612.2.6 Polyvinyl Chloride Drainage Pipe

- (1) Use polyvinyl chloride drainage pipe for underdrains conforming to AASHTO M 278.

612.2.7 Acrylonitrile-Butadiene-Styrene Drainage Pipe

- (1) Use acrylonitrile-butadiene-styrene drainage pipe for underdrains conforming to ASTM D 2751, except do not apply the requirements for joint tightness. The contractor may use pipe with a Standard Dimensional Ratio (SDR) wall thickness of SDR 35 for sizes 6 inches (150 mm) or smaller. Use pipe perforated according to AASHTO M 278, if perforated pipe is required.

612.2.8 Geotextile Fabric

- (1) Use a geotextile fabric of knitted, woven, or non-woven fibers of polyester, polypropylene, stabilized nylon, polyethylene, or polyvinylidene chloride. Do not use slit film woven fabrics for this work. The fabric must conform to the following requirements:

TEST	METHOD	VALUE ^[1]
Minimum grab tensile strength	ASTM D-4632	35 lb. (155 N)
Apparent opening size	ASTM D-4751	No. 30 - 200 (600 µm - 75 µm)
Minimum permittivity	—	1.35 s ⁻¹

^[1] All numerical values represent minimum/maximum average roll values (i.e., the average of minimum test results on any roll in a lot should conform to or exceed the minimum values in the table).

- (2) Use knitted fabrics constructed from continuous yarn. Non-woven fabrics may be needle-punched, heat-bonded, resin-bonded, or combinations of these 3 types. Use woven fabrics constructed from monofilament or multifilament yarns.
- (3) Use geotextile wraps of knitted construction that form a seamless sleeve and fit tightly over the pipe. If using geotextile wraps constructed from woven or non-woven fabric then tightly wrap and securely fix to the pipe.
- (4) Clearly mark the geotextile fabric rolls to identify the type of fabric.
- (5) If the engineer determines it is necessary, he can obtain fabric samples for testing from the job site.
- (6) If wrapping pipe underdrain, then the pipe shall conform to [612.2.5](#) for perforated underdrain.

612.2.9 Reinforced Concrete Apron Endwalls for Underdrain

- (1) Use material for endwalls conforming to [section 504](#).

612.3 Construction

612.3.1 Excavation

- (1) Construct trenches for the underdrain as near as possible to the locations, lines, and grades the plans show. However, if necessary, the engineer may alter the locations, lines and grades to fit existing conditions.
- (2) Begin trench excavation at the outlet end of the underdrain and proceed towards the upper end. Make trenches wide enough to provide adequate free working space on each side of the pipe and to allow compacting the backfill around the pipe. Restore all areas excavated below the established grade by adequately compacting and shaping a layer of suitable material.

612.3.2 Wrapping Pipe

- (1) Under the Pipe Underdrain Wrapped bid items, furnish and install pipe underdrain wrapped with geotextile fabric.
- (2) Wrap the geotextile fabric securely around the pipe underdrain along its entire length in a manner that allows no water to enter the underdrain without first passing through the fabric.
- (3) Furnish geotextile fabric in a cover that protects the fabric from exposure to sunlight and abrasion due to shipping and hauling. The contractor shall not expose the fabric to the direct rays of the sun for more than 48 hours before covering.
- (4) Cover torn or punctured fabric with suitable geotextile fabric extending at least 12 inches (300 mm) in all directions from the edge of the damaged fabric.
- (5) Overlap all joints or splices in the fabric a minimum of 18 inches (450 mm).

612.3.3 Laying Pipe

- (1) In general, start laying pipe in the trench at the outlet end and proceed toward the upper end, true to line and grade. Lay pipe with riveted lap joints so the flow is over the lap of the sheets. Make joints between sections by fitting the ends as tightly as possible. For tile pipe, cover all joints that do not close with less than 1/4 inch (6 mm) opening, with sections of broken tile. Use connecting bands to link the joints of corrugated steel or aluminum alloy pipe, and bolt or clamp firmly in place.
- (2) Securely connect sections of corrugated polyethylene pipe with fittings conforming to AASHTO M 252 or M 294. The contractor may use solvent-cement joints, or gasketed joints, to join smooth plastic pipe. Secure corrugated polyethylene pipe as necessary to prevent displacement during laying and backfilling.
- (3) Unless the engineer directs otherwise, lay perforated drainage pipe with the perforations on the underside of the pipe.
- (4) Close the dead ends of pipe securely with concrete plugs, or engineer-approved caps, or plugs fabricated from the same material used in the pipe.
- (5) Protect discharge ends of pipes with securely fastened engineer-approved gratings or screens.
- (6) For tile lines, use corrugated steel pipe conforming to [612.2.2](#) to make the underdrain for a distance of 10 feet (3 m) from the outlet end.
- (7) Furnish and place engineer-approved connectors to make lateral connections.

612.3.4 Plowing In Pipe

- (1) Under the Pipe Underdrain Wrapped and Plowed bid items, place the wrapped pipe underdrain by plowing and replacing the displaced materials in a single operation. Place a wrapped underdrain in one continuous line except as the plans show or the engineer directs. Connect the pipe underdrain with plastic pipe couplers.
- (2) Construct the underdrain at the location the plans show, and in a relatively straight line. Make the grade line follow as near as possible the grades the plans show or as the engineer directs to fit existing conditions.
- (3) Use equipment capable of installing the underdrains to the required grade and location by plowing and replacing the displaced materials, as determined in the field, all in a single operation. Use equipment that will not damage the existing pavement. Compact materials disturbed by the plowing operations to the engineer's satisfaction.
- (4) Reshape and re-compact the existing shoulder materials to the engineer's satisfaction. Use compaction equipment conforming to [301.3](#).
- (5) If using a tracked pull unit, then use rack pads on the track on both pavement and shoulder.
- (6) Close upgrade ends of the pipe with suitable caps to prevent trench backfill from entering.
- (7) Install all couplings, tees, and other fittings to prevent the infiltration of trench backfill material and ensure compatibility with the pipe.

612.3.5 Backfilling

- (1) Under the Underdrain Trench bid item, excavate and backfill underdrain trenches.
- (2) Unless specified otherwise, cover perforated pipe or drain tile immediately after laying with granular material, as the plans specify, or as the engineer approves, to one foot (300 mm) above the top of the tile or pipe. Make the granular fill a uniform depth on both sides of the tile or pipe, and a minimum of 8 inches (200 mm) wider than the outside diameter of the tile or pipe. Backfill the remainder of the trench with granular backfill.
- (3) The contractor may backfill unperforated pipe with suitable material from trench or roadway excavation unless granular backfill is specified.
- (4) Use coarse aggregate conforming to size No. 2 of [501.2.5.4](#) to backfill trench underdrain. Place the geotextile fabric in the trench according to plan details before backfilling.
- (5) If excavating for installing underdrains across private property, or within the right-of-way beyond the roadway limits, salvage the upper tillable or agricultural soil suitable for supporting vegetation and keep separate from other excavated material. Place this salvaged material in the top layer or layers of the backfill. Restore the entire area involved in the construction in a skilled and satisfactory manner.
- (6) Use open-graded material required for trench backfill in the edgedrain system for concrete pavements as the plans show.

612.3.6 Drain Tile Exploration

- (1) Under the Drain Tile Exploration bid item, excavate an exploratory trench to locate existing farm drain tile.
- (2) Perform the exploratory trenching in sufficient advance of the grading operations to allow uninterrupted progress of these operations.
- (3) Construct the trench a minimum 12 inches (300 mm) wide and deep enough to intercept all existing tile lines. Keep the trench open until the engineer orders it backfilled. Use the material obtained from the trench excavation for backfill.

612.3.7 Delivery

- (1) Do not order and deliver the pipe underdrains required until the engineer verifies sizes and lengths.

612.3.8 Reinforced Concrete Apron Endwalls for Underdrain

- (1) Under the Apron Endwalls for Underdrain Reinforced Concrete bid items, furnish and install reinforced concrete apron endwalls at underdrain outlets.
- (2) Install endwalls according to plan details, at the locations the plans show.

612.4 Measurement

- (1) The department will measure the Pipe Underdrain bid items by the linear foot acceptably completed. The department will measure along the centerline of the pipe, center to center of junctions and fittings.
- (2) The department will measure Underdrain Trench by the linear foot acceptably completed, measured along the bottom of the trench. The department will measure geotextile fabric separately.
- (3) The department will measure Drain Tile Exploration by the linear foot acceptably completed. The measured quantity equals the number of linear feet of trench opened at the engineer's direction.
- (4) The department will measure the Apron Endwalls for Underdrain Reinforced Concrete bid items as each individual unit acceptably completed.

612.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
612.0100 - 0199	Pipe Underdrain (inch)	LF
612.0200 - 0299	Pipe Underdrain Unperforated (inch)	LF
612.0300 - 0399	Pipe Underdrain Drain Tile (inch)	LF
612.0400 - 0499	Pipe Underdrain Wrapped (inch)	LF
612.0500 - 0599	Pipe Underdrain Wrapped and Plowed (inch)	LF
612.0600	Underdrain Trench	LF
612.0700	Drain Tile Exploration	LF
612.0800 - 0899	Apron Endwalls for Underdrain Reinforced Concrete (inch)	EACH

- (2) Payment for the Pipe Underdrain bid items is full compensation for providing, transporting, handling, and placing all materials, including pipe, geotextile wrapping, connections, fittings, rodent screens, and caps or plugs; for all excavating, plowing, and re-compacting, salvaging, and placing upper tillable or agricultural soil suitable for supporting vegetation, disposing of surplus material, and restoring the work site; and for backfill, except as specified below. The department will pay separately for open-graded material required for trench backfill in the edgedrain system for concrete pavements under the Base Aggregate Open Graded bid item.
- (3) Payment for Underdrain Trench is full compensation for excavating the trench, and for providing and placing all the backfill necessary to fill the trench. The department will pay for geotextile fabric separately.
- (4) Payment for Drain Tile Exploration is full compensation for all excavating, backfilling, and for restoring the work site.
- (5) Payment for the Apron Endwalls for Underdrain Reinforced Concrete bid items is full compensation for all excavating and backfilling; for providing, hauling and placing all materials, including concrete, and reinforcement at each unit; and for disposing of all surplus material.

SECTION 614 GUARD FENCE, BEAM GUARD, MARKER POSTS, AND CRASH CUSHIONS

614.1 Description

- (1) This section describes constructing cable guard fence, steel plate beam guard, steel three beam structure approach, anchorages, terminal ends, crash cushions, including replacement cartridges; sand barrels, and marker posts. This work also includes constructing and removing temporary steel plate beam guard and anchorages; the salvaging of guard fence; and the adjusting of steel plate beam guard.

614.2 Materials

614.2.1 General

- (1) Furnish materials conforming to the following:

Concrete	section 501
Paint	section 517
Creosote-coal tar solution	507.2.3
Structural steel	section 506
Steel reinforcement	section 505
Miscellaneous metals	section 506
Lumber and timber	section 507
Pentachlorophenol	507.2.3
Petroleum solvents	507.2.3
Chromated copper arsenate	507.2.3
Ammoniacal copper arsenate	507.2.3
Ammoniacal copper zinc arsenate	507.2.3
Copper naphthenate solution	507.2.3
- (2) Furnish grade A, A-FA, A-S, A-T, A-IS, or A-IP concrete conforming to [501.2](#).

614.2.2 Cable Guard Fence and Miscellaneous Hardware

614.2.2.1 General

- (1) Use cable, fittings, and miscellaneous hardware for constructing cable guard fence conforming to the requirements specified below and to all supplementary requirements for design and quality of appurtenant fittings and hardware as the plans show.

614.2.2.2 Cable for Guard Fence

- (1) Use wire cable conforming to AASHTO M 30.
- (2) Unless specified otherwise on the plans or in the contract, use 3/4-inch (19 mm) wire rope, type I, class A coating.

614.2.2.3 Hardware for Cable Guard Fence

614.2.2.3.1 General

- (1) Use zinc coated parts, hardware, and fittings. Use a zinc coating of the quality and weight specified in AASHTO M 232.
- (2) Use plate washers, hook bolts, cable fittings, bearing blocks, splice, turnbuckle, and anchor assemblies conforming to plan dimensions and requirements.
- (3) Unless specified otherwise, for assembling the cable guard fence use bolts conforming to ASTM F 568, class 4.6, and nuts conforming to AASHTO A 563, class 5.

614.2.2.3.2 Fittings

- (1) Externally threaded fittings, for example, end tie rods, anchor, and splicing rods that transmit direct tensile stress shall have a minimum tensile strength of 75 000 pounds per square inch (517 MPa). All internally threaded fittings, for example, turnbuckles, cable sockets, and nuts shall withstand a proof load equal to 85 percent of the proof load requirements for nuts specified in Table 3 of ASTM A 563. All cable splices and connections shall withstand a proof load equal to the tensile strength required of the attached wire rope cable.

- (2) Use rectangular plate washers and cable clamps made from steel and having a tensile strength of not less than 60 000 pounds per square inch (414 MPa). Use plain washers made of ferrous metal conforming to ANSI B 18.22.1, M.
- (3) Use concrete bearing blocks made of precast reinforced concrete conforming to the design and dimensions the plans show.

614.2.2.3.3 Anchor Rod Assembly

- (1) An anchor rod assembly includes anchor rod, turnbuckle, anchor block, and all plates, washers, and nuts required. Ensure all rods have 1 1/4 inch (32 mm) nominal diameter unless shown otherwise. Use turnbuckles made from drop-forged steel or malleable iron with a take-up of at least 6 inches (150 mm). The complete assembly must have a minimum tensile strength of 75 000 pounds per square inch (517 MPa).
- (2) Use anchor blocks made of precast reinforced concrete conforming to the design and dimensions the plans show.

614.2.3 Steel Plate Beam and Fittings

- (1) Use steel plate beam conforming to class A, type II, beam in AASHTO M 180, with the following exceptions and requirements. The single-spot test is required. Shape, punch, and fabricate the beams, terminal and end sections, post anchor brackets, and other fittings as the plans show. Protect the beam and fittings by elevating off ground and from surface runoff before erecting. The department may reject all elements abraded through the zinc coating, or if white rust or zinc oxide has formed on them. The contractor may mechanically zinc coat bolts, nuts, and washers.
- (2) Furnish plates, anchor plates, post mounting brackets, and channel rail elements made of structural steel conforming to the requirements of [506.2.2.1](#). Use steel tubes for breakaway posts conforming to ASTM A 500, grade B. Zinc coat plates, anchor plates, and post mounting brackets and channel rail elements according to AASHTO M 111.
- (3) Use wire cable for anchorages conforming to [614.2.2.2](#).
- (4) Use cable assemblies for anchorages conforming to the following:
 1. Use hot-rolled carbon steel swaged fittings conforming to ASTM A 576, grade 1035, and are annealed suitable for cold swaging. Zinc coat the swaged fitting according to ASTM A 123 before swaging. Drill a lock pinhole to accommodate a 1/4-inch (7 mm), plated, spring steel pin through the head of the swage fitting to hold the stud in the proper position. After zinc coating, the contractor may tap the head 0.023 inch (0.6 mm) over the ANSI class 2B tolerance.
 2. Use a stud conforming to ASTM A 568 class 8.8 and zinc coat according to ASTM A 153. Ensure the threads have a class 2A fit before zinc coating. Before zinc coating, mill a 3/8-inch (10 mm) slot into the stud end for the locking pin.
 3. Ensure wire rope with connecting hardware attached develop the full 25 Kip (110 KN) strength of a single cable.

614.2.3.1 Energy Absorbing Terminal

- (1) Furnish and use materials in energy absorbing terminals for steel plate beam guard conforming to the manufacturer's specifications.

614.2.4 Sawed Posts for Beam Guard

614.2.4.1 Species of Wood

- (1) Construct steel plate beam guard or steel plate beam median guard from sawed posts of one of the following species:

Douglas fir	Southern pine	Ponderosa pine	Jack pine	White pine
Red pine	Western hemlock	Western larch	Hem-fir	Oak

614.2.4.2 Requirements

- (1) Ensure that posts are the size the plans show and conform to the nominal and minimum dimensions tabulated in [507.2.2.3](#). The contractor does not have to surface the posts. Provide the net length the plans show after setting and shaping.
- (2) Use stress graded posts rated at 1200 psi (8 280 kPa) f_b or higher. Determine the stress grade rating for douglas fir, western larch, and southern pine as specified in [507.2.2.4](#).

- (3) For hem-fir, hemlock, red pine, white pine, jack pine, ponderosa pine, and oak; conform to the following:

SPECIES			WESTERN HEMLOCK, HEM-FIR, RED PINE, WHITE PINE, JACK PINE, PONDEROSA PINE		OAK	
MAXIMUM SLOPE OF GRAIN			1 in 15		1 in 12	
NOMINAL WIDTH OF FACE			6" (152 mm)	8" (203 mm)	6" (152 mm)	8" (203 mm)
SHAKES, CHECKS, AND SPLITS	GREEN		1" (25 mm)	1 3/8" (35 mm)	2 3/8" (60 mm)	3 1/8" (79 mm)
	SEASONED		1 1/2" (38 mm)	2" (51 mm)	2 5/8" (67 mm)	3 1/2" (89 mm)
MAXIMUM WANE			1" (25 mm)	1 3/8" (35 mm)	1 1/8" (29 mm)	1 5/8" (41 mm)
MAXIMUM ALLOWABLE KNOTS	NARROW FACE	MIDDLE 1/3 OF LENGTH	1 3/8" (35 mm)	1 5/8" (41 mm)	2 1/8" (54 mm)	2 3/8" (60 mm)
		END ^[1]	2 3/4" 70 mm)	3 1/4" (83 mm)	4 1/4" (108 mm)	4 3/4" (121 mm)
		SUM IN MIDDLE 1/2 OF LENGTH ^[2]	11" (279 mm)	13" (330 mm)	17" (432 mm)	19 (483 mm)
	WIDE FACE	EDGE KNOT N MIDDLE 1/3 OF LENGTH	1 3/8" (35 mm)	1 5/8" (41 mm)		
		EDGE KNOT AT END ^[1]	2 3/4" 70 mm)	3 1/4" (83 mm)		
		CENTERLINE	1 3/8" (35 mm)	1 7/8" (48 mm)	2 1/4" (57 mm)	2 7/8" (73 mm)
		SUM IN MIDDLE 1/2 OF LENGTH	5 1/2" (140 mm)	7 1/2" (190 mm)	9" (229 mm)	11 1/2" (292 mm)

^[1] But do not exceed the maximum allowable knot on the centerline of the wide face of the same piece.

^[2] But do not exceed 4 times the maximum allowable knot on the centerline of the wide face of the same piece.

614.2.5 Round Posts for Cable Guard Fence

- (1) Use one of the softwood species listed in [614.2.4.1](#)
- (2) Cut and manufacture posts from live, green, growing trees. Stack and season these posts in a manner approved by the American Wood Standards.
- (3) Peel the entire length of each post, closely trim knots, saw both ends square, and shave the entire length of the post to the white.
- (4) Make the post a sufficient length to provide, after setting and shaping, the net length the plans show. Ensure the top diameter of each post after shaving is within 1/2 inch (13 mm) less than and 1 1/4 inch (32 mm) more than the nominal top diameter the plans show.
- (5) Ensure all posts are free from sap rot, woodpecker holes, plugged holes, ant eaten areas, and hollow knots extending to center of post. Butt rot may not exceed 5 percent of the butt area. Ensure that the tops of all posts are sound. The department will allow one pipe rot not exceeding 3/8 inch (10 mm) in diameter exist in a cedar post having a net top diameter of 6 inches (150 mm) or more.
- (6) Use posts that are sound and show no evidence of excessive checking, short kinks, or one-way sweep exceeding 2 inches (50 mm). Posts may have winding twist unless unsightly and excessive.

- (7) The contractor shall not use posts having both the maximum crook and maximum butt rot. Not more than 10 percent of the posts required under the contract may contain the maximum crook or the maximum butt rot.
- (8) The department may reject posts for other defects of any kind that give a post an unsightly appearance or impair its durability or strength.
- (9) Complete all debarking, trimming and sizing operations before treatment.

614.2.6 Preservative Treatment

- (1) Unless specified otherwise on the plans or in the contract, treat all posts furnished for beam guard or guard fence with one of the following:
 - Creosote-coal tar solution.
 - Pentachlorophenol^[1] solution, in heavy petroleum solvent.
 - Chromated copper arsenate solution.
 - Ammoniacal copper arsenate solution.
 - Ammoniacal copper zinc arsenate solution.
 - Copper naphthenate solution.

^[1] The pentachlorophenol-petroleum solution should contain a minimum of 5 percent pure pentachlorophenol, by weight, of the total solution.

- (2) Treat all posts used in one continuous section of run of beam guard or guard fence with the same type of preservative.
- (3) Use the pressure process to apply preservative treatment to the posts as specified in [507.2.2.6](#).

614.2.7 Marker Posts

614.2.7.1 Wooden Posts

- (1) Use round posts made from one of the softwood species listed in [614.2.4.1](#).
- (2) Ensure wooden marker posts conform to [614.2.5](#). Except, the department may allow a one-way sweep exceeding 3 inches (75 mm).
- (3) Unless provided otherwise, use untreated wooden marker posts.

614.2.7.2 Recycled Plastic Posts

- (1) Use recycled plastic posts for marker posts for right-of-way manufactured from recycled plastic of at least 95 percent high-density polyethylene, obtained from post consumer products. Use posts colored yellow throughout with an ultraviolet ray inhibitor added to prevent color fading. Use Federal Highway Standard 595a-33538 according to the Federal Highway Administration color tolerance chart for standard highway yellow. Ensure posts are solid and free from cracks or other defects that cause them to have an unsightly appearance or impair their durability or strength. Do not use posts having a one-way sweep exceeding 1/4 inch (6 mm). Furnish and use posts conforming to the details and dimensions the plans show and are able to sustain normal loadings at temperatures between -25 F and 100 F (-32 C and 38 C) without distortion.

614.2.8 Sand Barrels

- (1) Furnish sand barrels from the department's approved products list or as the contract specifies. Fill barrels with sand conforming to the requirements of [501.3.6.3](#). Mix sand with sodium chloride conforming to the requirements of AASHTO M 143.

614.2.9 Crash Cushions

- (1) Furnish permanent and temporary crash cushions from the department's approved products list or as the contract specifies. Submit a manufacturer set of design details to engineer before installing.

614.3 Construction

614.3.1 Placing Posts for Cable Guard Fence

- (1) Under the Cable Guard Fence bid item, provide 3 lines of cable supported on treated wooden posts, unless specified otherwise.
- (2) Set the posts in holes dug in the ground at the required locations. Compact the bottom of the holes so the posts have a stable foundation.

- (3) The department will allow a tolerance of +/- 3 inches (75 mm) in the depth of holes for posts, provided the post length is adequate to obtain required elevation for finished top.
- (4) Space the posts as the plans show, and set plumb with the front faces in a straight line or, if on a curve, at a uniform distance from the centerline. After placing the posts, backfill the holes with engineer-approved material, compact in layers in a manner that does not shift the posts from the correct position or alignment. Then drive the posts to a firm bearing with at least a 13-pound (6 kg) maul. Determine the finished elevation of the post top after setting the post, and cut off the top of the post to this elevation, as the plans show. Round the tops of round posts in a manner that centers the dome on the axis of the post. After cutting off treated posts, apply 2 coats of the preservative originally used to treat the post to the cut surfaces.
- (5) The contractor may drive posts instead of setting posts in previously dug holes and backfilling, except if bearing blocks are required. If driving posts, then drive them plumb, to the required depth and alignment, with adequate lateral stability. Ensure the shoulders and adjacent slopes are not damaged by the driving operations. Remove and replace any post that fails to conform to the above requirements, or becomes damaged below cutoff during driving with a sound post.

614.3.2 Placing Anchors, Cable, and Fittings for Cable Guard Fence

- (1) Under the Anchorages for Cable Guard Fence bid item, furnish cast in place concrete anchors for cable guard fence.
- (2) Place and securely fasten the anchors, cables and fittings in a competent manner, as the plans show. If bolts project more than one inch (25 mm) from the nut, cut them off 1/2 inch (13 mm) from the nut, or as the plans show, and burr them. Paint the ends of cut-off bolts with an engineer-approved zinc rich paint. Bore holes for cable supports after setting the posts to line and grade.
- (3) Place end and intermediate anchorages and bearing blocks at the locations the plans show.
- (4) Excavate the trenches for anchor blocks to the neat lines of the anchor block to be placed, as the plans show. Excavate in a manner that avoids further disturbance of the earth between the block and the anchored posts than necessary to allow installing the anchor rod. Place the block with anchor rod in place, against the undisturbed earth. The contractor shall not apply final tension to the anchor assembly until after completing the backfilling. Place and compact backfill material in layers. Excavate holes for bearing blocks to the neat lines of the block and place the block on undisturbed soil and level to allow the post's full bearing.
- (5) After completing the anchor assemblies, adjust and fasten the cables properly and securely, draw uniformly taut and then loosen as the plans show for the applicable temperature range.
- (6) Affix reflective sheeting, 3 inches (75 mm) wide, conforming to [637.2.2.1](#) for standard reflective sheeting, Silver White No. 2, mounted on flexible aluminum alloy, to each end post and at maximum intervals of 100 feet (30 m) on intermediate posts with a minimum of 3 strips on all installations.
- (7) Wrap the reflective strips completely around each post before installing the post plate washers.
- (8) If manufacturing concrete used in precast anchor and bearing blocks, conform to [614.3.3](#).

614.3.3 Erecting Steel Plate Beam Guard

614.3.3.1 General

- (1) Under the Steel Plate Beam Guard Class A bid item, provide a single steel beam, fabricated from steel plate to specified shape and dimensions, attached to treated posts and offset blocks, unless specified otherwise.
- (2) Under the Steel Plate Beam Guard Over Low-Fill Culverts Class A bid item, provide nested class A beam guard spanning less than 25 feet (7.62 m) over culvert structures with shallow cover.
- (3) Under the Steel Plate Beam Guard Class B bid item, provide a single steel beam, fabricated from steel plate to specified shape and dimensions, supported on treated wood posts, unless specified otherwise.
- (4) Under the Steel Plate Beam Median Guard bid item, provide 2 lines of steel beams and 2 lines of steel channels, each line supported on opposite sides of a single line of treated wood posts with the steel beams attached to offset blocks, unless specified otherwise.
- (5) Under the Steel Plate Beam Guard Temporary and Steel Thrie Beam Structure Approach Temporary bid items, furnish, install, and maintain temporary beam guard conforming to the requirements for Steel Plate Beam Guard Class A, except the contractor may furnish used materials. Remove and dispose of the beam guard when no longer needed.

- (6) Under the Steel Thrie Beam Structure Approach bid item, provide beams fabricated from steel plate to specified shape and dimensions, attached to treated wood posts and offset blocks, unless specified otherwise.
- (7) Set or drive posts at the spacing the plans show and in the manner specified above for cable guard fence. After setting or driving the posts to proper line and grade, bore holes at the proper locations to receive the bolts for attaching offset blocks, beam rail, and channel rail, if required. If using offset blocks, make them conform to the dimensions the plans show, of the same materials, and have the same preservative treatment specified for the posts. After erection, cut off the posts at the required elevation and in the manner the plans show. Give all cut surfaces of posts or offset blocks 2 applications of the preservative originally used to treat the posts. Instead of the original preservative, the contractor may use a 2-percent solution of copper naphthenate conforming to AWWA Standard P8.
- (8) Erect beam rails that splice by lapping, with the lap in the direction of traffic. Place the round head of bolts that go through the rail on the traffic side. Equip the ends of each section of beam guard, if not attached to a structure, or to cast in place concrete anchors, with terminal sections conforming to plan.
- (9) Make all splices, including splices of existing rail to new rail, at posts. Ensure the splice, including the number and dimensions of holes and bolts, conforms to the requirements for splices for new railing as the plans show.
- (10) Cut beam rails, if necessary, by shearing. Drill holes for bolts. The contractor shall not use cutting torches.
- (11) Install reflectors conforming to plan details at the locations, spacing, and as the plans specify.
- (12) After erecting the rails, cut off all anchor bolts that project more than one inch (25 mm) from the nut, to 1/2 inch (13 mm) from the nut, except studs for cable assemblies. Burr the threaded end of the cutoff bolt. After completing erection, paint the ends of cut-off bolts and all abraded or damaged zinc coated surfaces with 2 coats of engineer-approved zinc rich paint. Clean the damaged and adjacent areas thoroughly before applying.
- (13) Under the Anchorages for Steel Plate Beam Guard bid item, furnish cast in place concrete anchorages for Steel Plate Beam Guard Class A or Steel Plate Beam Median Guard.
- (14) Under the Anchorages for Steel Plate Beam Guard Temporary bid item, furnish and remove cast in place concrete anchorages for temporary steel plate beam guard. Conform to the requirements for permanent beam guard anchorages.
- (15) Under the Anchorages for Steel Plate Beam Guard bid item of the specified type, furnish cable anchorages for class A steel plate beam guard.
- (16) Under the Anchor Assemblies for Steel Plate Beam Guard bid item, furnish and install anchors for steel plate beam guard and steel thrie beam structure approach in the parapets of structures.
- (17) The contractor shall not use forms when placing the concrete for the anchor. Fill the entire excavation with concrete to the indicated top of the anchor the plans show.
- (18) For the manufacture of concrete, the engineer may waive the requirements for proportioning by weight and may allow mixers or mixing methods other than those ordinarily specified, provided they produce a concrete mixture equal in quality to that produced by equipment and methods specified in [section 501](#).
- (19) If casting the concrete anchor, ensure the rods and rail element are in place. The contractor shall not apply forces to the rail element embedded in the concrete anchor until after the concrete attains sufficient strength to support the force or a minimum of 3 days.
- (20) Place and securely fasten the cable assemblies for anchorages in a competent manner, and as the plans show.

614.3.3.2 Energy Absorbing Terminal

- (1) Under the Steel Plate Beam Guard Energy Absorbing Terminal bid items, furnish and install energy absorbing terminal ends according to the manufacturer's instructions and as the plans show.
- (2) Under the Steel Plate Beam Guard Energy Absorbing Terminal Temporary bid item, also remove and dispose of crash cushions when no longer needed.

614.3.4 Adjusting Steel Plate Beam Guard

- (1) Under the Adjusting Steel Plate Beam Guard bid item, adjust the existing steel plate beam to the plan height. Use the existing guardrail beam, bolts, posts, and block unless they become damaged or lost in this operation. Replace damaged material.

614.3.5 Salvaged Guard Fence

- (1) Under the Salvaged Guard Fence bid item, remove and reset existing cable guard fence or steel plate beam guard.
- (2) Remove and store the cables or beam rails, and all posts, offset blocks, bolts, fittings, and appurtenant hardware until re-erected in a manner that prevents damage.
- (3) Re-erect the guard fence at the new location in the same manner specified above for erection of that particular type of guard fence.
- (4) For salvaged cable guard fence, the contractor may construct the anchor assemblies with suitable salvaged parts supplemented with new parts as required.

614.3.6 Marker Posts

- (1) Under the Marker Posts bid item, provide untreated round wooden posts, unless specified otherwise, erected, and painted.
- (2) Under the Marker Posts for Right-of-Way bid item, provide square recycled plastic posts, erected with state-furnished markers attached.

614.3.6.1 Placing Wooden Posts

- (1) Excavate holes at the required locations and to the required depth. Set the wooden posts in the holes in a true vertical position. Unless directed otherwise, place posts in a straight line on shoulders or, if on a curve, at a uniform distance from the centerline. After placing the posts, backfill the holes with suitable material. Place and compact the backfill material in layers and in a manner that does not shift the post from its true position. After erection, cut off the top of the post at the proper elevation and round as the plans show.
- (2) If attaching delineators, notch the marker posts as the plans show. Drill a one inch (25 mm) hole transversely through the center of marker post at the ground line when diameter of post is greater than 5 1/2 inches (140 mm), or make a transverse saw cut approximately one inch (25 mm) deep on the side of the post facing traffic.
- (3) The contractor may round the tops of marker posts and paint them with a prime coat of paint before erection. After the prime coat is thoroughly dry, erect the post with the top at the required elevation.

614.3.6.2 Painting Wooden Posts

- (1) Paint untreated wooden marker posts as specified painting in [section 517](#), and in the manner specified below. Paint all marker posts with at least 3 coats of paint. The prime coat shall consist of the first coat of paint and a minimum of 2 other coats will consist of a total of 3 coats. Prime posts before erection, stack, store, and handle the posts in a manner to prevent damage or marring of the paint. Apply all other coats of paint after erecting the posts.
- (2) For the prime coat use white paint for wood as specified in [517.2.6](#). Apply the prime coat from the top of the post to a point at least 3 inches (75 mm) below the ground line.
- (3) For the second and third coats of paint, use white paint for wood as specified in [517.2.6](#). Apply these coats from the top of the post to a point 24 inches (600 mm) below, and then apply 2 coats of black paint for wood as specified in [517.2.8](#), from a point 21 inches (530 mm) below the top of the post to a point 3 inches (75 mm) below the ground line. If the plans show, form a cap of the required dimensions on the top of the post by applying 2 additional coats of the black paint.
- (4) The contractor shall not apply paint unless the air temperature is above 40 F (4 C). The contractor shall also not apply on damp or dirty surfaces, on material containing frost, if the air is misty, or if the engineer determines conditions are unsatisfactory otherwise for this work.
- (5) Stir all paint thoroughly. While painting, stir the paint often enough to keep the pigments suspended.

- (6) Brush each coat of paint into the wood and allow to dry according to the manufacturer's requirements before applying the succeeding coat. Make the lines of demarcation between the white and black paints horizontal, sharp, and well defined.

614.3.6.3 Placing Recycled Plastic Posts

- (1) Set recycled plastic posts into excavated holes to the required depth, to a true vertical position, at the locations the plans show or as the engineer directs. Use equipment that causes no damage to the posts. Attach the department furnished right-of-way information plaque to the post.
- (2) Replace any damaged or missing posts necessary.

614.3.7 Sand Barrels

- (1) Under the Sand Barrels bid item, furnish and install sand-filled inertial barriers according to the manufacturer's instructions and the plans.
- (2) Fill the barrels with a mixture of sand and sodium chloride. Mix the sand and sodium chloride to a 3:1 ratio by volume. Stockpile the mixture in the open air for one week and mist each day with water spray to provide a coating of sodium chloride to the sand particles. Test the mixture for sodium chloride content just before placing into the barrels, at this time the mixture shall contain a minimum of 20 percent sodium chloride by dry weight. The contractor shall not place the mixture into the barrels in a wet condition.
- (3) Construct concrete sidewalk pads to conform to [section 602](#) and to the elevations the engineer determines.

614.3.8 Crash Cushions

- (1) Under the Crash Cushion bid items, furnish, install, and maintain construction zone crash cushions as the manufacturer specifies and the plans show. Replace damaged parts of the crash cushion.
- (2) Under the Crash Cushions Temporary bid item, also remove and dispose of crash cushions when no longer needed.

614.4 Measurement

- (1) The department will measure Cable Guard Fence and Salvaged Guard Fence Cable by the linear foot acceptably completed, measured as the length from center to center of end posts.
- (2) The department will measure Anchorages for Cable Guard Fence, the Anchorages for Steel Plate Beam Guard bid items, Anchor Assemblies for Steel Plate Beam Guard, the Steel Plate Beam Guard Energy Absorbing Terminal bid items as each individual unit acceptably completed.
- (3) The department will measure the Steel Thrie Beam Structure Approach bid items by the linear foot acceptably completed.
- (4) The department will measure the Steel Plate Beam Guard (class) bid items, Steel Plate Beam Guard Over Low-Fill Culverts Class A, Steel Plate Beam Guard Temporary, Adjusting Steel Plate Beam Guard, and Salvaged Guard Fence Steel Beam by the linear foot acceptably completed, measured along the face of the rail element.
- (5) The department will measure Steel Plate Beam Median Guard by the linear foot acceptably completed, measured along the centerline of the completed installation.
- (6) The department will measure the Marker Posts and Crash Cushions bid items as each individual unit acceptably completed.
- (7) The department will measure Sand Barrels as each individual system acceptably completed.

614.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
614.0100	Cable Guard Fence	LF
614.0103	Anchorages for Cable Guard Fence	EACH
614.0105	Anchorages for Steel Plate Beam Guard	EACH
614.0110	Anchorages for Steel Plate Beam Guard Temporary	EACH
614.0115 - 0149	Anchorages for Steel Plate Beam Guard (type)	EACH
614.0150	Anchor Assemblies for Steel Plate Beam Guard	EACH

614.0200	Steel Thrie Beam Structure Approach	LF
614.0250	Steel Thrie Beam Structure Approach Temporary	LF
614.0300 - 0339	Steel Plate Beam Guard (class)	LF
614.0340	Steel Plate Beam Guard Over Low-Fill Culverts Class A	LF
614.0355	Steel Plate Beam Median Guard	LF
614.0360	Steel Plate Beam Guard Temporary	LF
614.0370	Steel Plate Beam Guard Energy Absorbing Terminal	EACH
614.0380	Steel Plate Beam Guard Energy Absorbing Terminal Temporary	EACH
614.0400	Adjusting Steel Plate Beam Guard	LF
614.0500	Salvaged Guard Fence Cable	LF
614.0555	Salvaged Guard Fence Steel Beam	LF
614.0600	Marker Posts	EACH
614.0605	Marker Posts Right-of-Way	EACH
614.0700	Sand Barrels	EACH
614.0800	Crash Cushions Permanent	EACH
614.0805	Crash Cushions Permanent Low Maintenance	EACH
614.0905	Crash Cushions Temporary	EACH
(2) Payment for Cable Guard Fence is full compensation for all materials, including posts, cable, tension assemblies, bearing blocks, beams, channels, fittings, painting, and incidentals; for setting and driving posts; and for all excavating, backfilling, and disposing of surplus material. The department will pay separately for anchorages under the Anchorages bid items.		
(3) Payment for Anchorages for Cable Guard Fence, Anchorages for Steel Plate Beam Guard, Anchorages for Steel Plate Beam Guard Type 2, and Anchor Assemblies for Steel Plate Beam Guard is full compensation for providing all materials, except right-of-way information plaque; and for placing all materials, including posts, paint, concrete, rods, cables, anchors and fixtures; and for all excavating, backfilling and disposing of excess material.		
(4) Payment for Anchorages for Steel Plate Beam Guard Temporary is full compensation for providing anchorages, including concrete and rods; for all excavating and backfilling; and for removing and disposing of all materials. The department will not pay for concrete placed outside the concrete anchor dimensions the plans show.		
(5) Payment for the Steel Thrie Beam Structure Approach bid items is full compensation for providing thrie beams, including posts, bearing blocks, terminal connector, beams, fittings and hardware; for setting and driving posts; and for all excavating, backfilling, and disposing of surplus material.		
(6) Payment for the Steel Plate Beam Guard (class) bid items, Steel Plate Beam Guard Over Low-Fill Culverts Class A, and Steel Plate Beam Median Guard is full compensation for providing beam guard, including posts, cable, tension assemblies, bearing blocks, beams, channels, fittings, painting, and incidentals; for setting and driving posts; and for all excavating, backfilling, and disposing of surplus material. The department will pay separately for anchorages under the Anchorages bid items.		
(7) Payment for Steel Plate Beam Guard Temporary is full compensation for providing temporary beam guard, including posts, beams, and hardware; and for removing and disposing of all materials. The department will pay separately for anchorages under the Anchorages bid items.		
(8) Payment for the Steel Plate Beam Guard Energy Absorbing Terminal bid items is full compensation for providing energy absorbing terminals required under the selected system; for setting and driving posts; and for all excavating, backfilling, and disposing of surplus material.		
(9) Payment for Adjusting Steel Plate Beam Guard is full compensation for adjusting existing steel plate beam guard; and for replacing damaged material.		
(10) Payment for Salvaged Guard Fence Cable and Salvaged Guard Fence Steel Beam is full compensation for removing, handling, storing, and transporting the existing fence materials; for re-erecting posts, cables, beams, and fittings; and for all excavating, backfilling, and disposing of surplus material. The contractor is responsible for all parts damaged by its operations and will replace damaged parts at no expense to the department. Payment does not include anchorages; the department will pay for these separately as specified below.		

- (11) Payment for the Marker Posts bid items is full compensation for providing marker posts, except right-of-way information plaque; and for placing all materials, including posts, paint, concrete, rods, cables, anchors and fixtures; and for all excavating, backfilling and disposing of excess material.
- (12) Payment for Sand Barrels is full compensation for providing sand barrels, including barrels, sand, sodium chloride, and watering.
- (13) Payment for Crash Cushions Permanent and Crash Cushions Permanent Low Maintenance is full compensation for providing crash cushions, including beam guard; and for maintaining, including providing replacement components if needed.
- (14) Payment for Crash Cushions Temporary is full compensation for providing crash cushions, including beam guard; for maintaining, including providing replacement components if needed; and for dismantling and removing.

SECTION 615 TREATED RUSTIC TIMBER ITEMS AND HISTORICAL MARKERS

615.1 Description

- (1) This section describes constructing timber rail guard fence, treated timber curbs, timber guard posts, rustic marker posts, and historical markers, appropriate for use in rest areas or waysides.

615.2 Materials

615.2.1 General

- (1) Furnish materials conforming to the following:

Lumber and timber.....	section 507
Paint	section 517
Wood preservatives	507.2.3
Structural steel	506.2
Miscellaneous metals	506.2
Reinforcement	section 505
Concrete	section 501

615.2.2 Sawed Posts and Timber Curbs

- (1) Conform to the requirements in [614.2.4](#).
- (2) The contractor may use shims for timber curbs that are one of the following: treated, cold-dip treated, or painted with 2 coats of the preservative used for the curbs.

615.2.3 Round Posts

- (1) Conform to the requirements for wooden posts in [614.2.7](#). Treat round posts as specified on the plans or in the contract. Peel, trim, shave, and cut posts to length before treatment.

615.2.4 Timber Rails

- (1) Furnish sawed rails from one of the species listed in [614.2.4.1](#) for timber rail guard fence.
- (2) Furnish untreated sawed rails, unless required otherwise on the plans, conforming to the grade the plans specify. Grade sawed rails according to the grading rules and requirements specified in [507.2.2](#). Furnish unsurfaced sawed rails, or surfaced on all 4 sides (S4S), as the plans specify.

615.2.5 Furnishing Posts

- (1) Furnish treated, untreated, or cold-dip treated posts, as the plans, or contract specifies.
- (2) If treated posts are specified, then treat posts by the pressure process according to the methods, requirements, and minimum retention and penetration of preservative specified for preservative treatment in [614.2.6](#). Except, do not use creosote-coal tar or pentachlorophenol for treatment.
- (3) If the plans or contract specifies cold-dip treatment, then treat posts in the manner specified below in [615.2.6](#).

615.2.6 Cold-Dip Treatment

- (1) This method of preservative treatment consists of immersing the wood in a solution composed of 5 percent pentachlorophenol and a suitable petroleum solvent. Allow the wood to soak in the solution. Ensure the pentachlorophenol and petroleum solvent conforms to the requirements of [507.2.3](#). Unless directed otherwise, use heavy petroleum solvent. The contractor may use the solution at atmospheric temperatures. The contractor may treat both round wood posts and sawed timber. Remove both the outer and inner bark from round wood. Use sufficiently seasoned material for treatment that allows ready absorption of the preservative solution. Allow wood exposed to moisture to dry before treating.
- (2) The soaking period for both round wood and sawed timber is dependent on the type of wood, hardwood or softwood, and if using sawed timber, varies according to the thickness of its least dimension. Unless specified otherwise, adhere to following soaking periods:
 - For round hardwood posts: 40 to 48 hours.^[1]
 - For round softwood posts: 20 to 24 hours.^[1]

^[1] Depending on the tendency and speed of the wood to absorb the oil.

- (3) Soak sawed hardwood timber for 5 hours per inch (25 mm) of thickness, with a maximum of 48 hours.

- (4) Soak sawed softwood timber 1/2 the time of sawed hardwood timber.
- (5) Treat posts for their full length unless the drawings or special provisions specify butt treatment.
- (6) Before using, stack and dry all treated wood after removing from the solution.
- (7) Butt treatment of posts consists of performing the cold-dip method of preservative treatment, on the ends of the posts to be set in the ground. Immerse the posts in the preservative solution, for the required time, to a depth equal to the depth the post will set in the ground plus 6 inches (150 mm).

615.2.7 Bolts, Nuts, and Hardware

- (1) Furnish all bolts, nuts and miscellaneous hardware for the work according to the design and dimensions the plans show. Furnish sufficiently threaded bolts to allow secure fastening and supply with the necessary washers.
- (2) Unless specified otherwise, furnish all bolts, nuts, washers and other hardware zinc coated. Except that the contractor may furnish plain hardware for timber guard fence and treated timber curbs. The zinc coating must conform to methods specified in [614.2.2.3](#).

615.3 Construction

615.3.1 General

- (1) Under the Guard Fence Timber Rail bid item, support a timber rail on wooden posts.
- (2) Under the Guard Posts Timber bid item, furnish and erect sawed wooden posts.
- (3) Under the Marker Posts Rustic bid item, furnish and erect round wooden posts.
- (4) Construct all work according to the plan details specified for the work. Dig the post holes at the required location and depth, and compact the bottom of the holes to provide a stable foundation. The engineer will allow a tolerance of +/- 3 inches (75 mm) in depth, provided the post length is adequate to obtain the required elevation of the finished top. Set the posts plumb and with the front faces in a straight line or to conform to curves the plans show or as the engineer directs. Backfill the placed posts with engineer-approved material, placed in layers, and compacted in a manner that avoids disturbing the position or alignment of the post.
- (5) After setting the post, determine the finished elevation of the post top and cut off and trim as the plans show. Treat the cut surfaces of treated posts with 2 brush applications of the same type of preservative used in the original treatment. Bore holes in the set posts to support the rails at the required elevation and grade. Bolt the rails to the posts, unless specified otherwise, with round-headed bolts, with heads facing the rail. Burr the threaded ends of all bolts. If the bolt extends one inch (25 mm) or more through the nut, cut off at 1/2 inch (13 mm) from the nut before burring.
- (6) Under the Curbs Treated Timber bid item, anchor and support sawed treated timbers on shims.
- (7) Perform the drilling, countersinking and beveling of curbs after pressure treatment; however, apply 2 brush applications of the preservative used for the curbs to the surfaces that result from this operation.
- (8) Place timber curbs true to line and grade, with the supporting shims placed on a solid foundation. Secure the curbs in place by driving steel pins to firm seating in holes countersunk in the curbs.
- (9) Under the Wisconsin Historical Marker bid items, construct a reinforced concrete base, if required, wood post, concrete or stone supports, and hang the designated department-furnished sign.
- (10) Construct historical markers according to the plans and applicable special provisions.

615.3.2 Painting

- (1) Unless directed otherwise, paint all untreated wood, rails and posts, including the untreated portions of butt treated posts, with 2 coats of brown wood stain conforming to [517.2.9](#). Allow at least 48 hours to elapse between coats.
- (2) This work shall conform to whatever paint or methods of application the plans or special provisions specify.

615.4 Measurement

- (1) The department will measure Guard Fence Timber Rail by the linear foot acceptably completed, measured from end to end of the rail.

- (2) The department will measure Curbs Treated Timber, Guard Posts Timber, and Marker Posts Rustic as each individual unit acceptably completed.
- (3) The department will measure the Wisconsin Historical Marker bid items as a single lump sum unit for each marker acceptably completed.

615.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
615.0100	Guard Fence Timber Rail	LF
615.0200	Curbs Treated Timber	EACH
615.0300	Guard Posts Timber	EACH
615.0400	Marker Posts Rustic	EACH
615.1000	Wisconsin Historical Marker project)	LS

- (2) Payment for Guard Fence Timber Rail is full compensation for providing all materials, including posts, rails, bolts, paint, preservative and incidentals; for all excavating, erecting, backfilling and disposing of surplus materials; and for preservative treating and painting.
- (3) Payment for Curbs Treated Timber, Guard Posts Timber, or Marker Posts Rustic is full compensation for all materials, including posts, curbs, shims, treatment, painting, pins, and incidentals; and for excavating, backfilling, and disposing of excess material.
- (4) Payment for the Wisconsin Historical Marker bid items is full compensation for providing all materials, including posts, stones, reinforcement and concrete if required, paint, bolts, and incidentals; for excavating, erecting, backfilling, and disposing of surplus materials; and for preservative treating, and painting.

SECTION 616 PROPERTY AND RIGHT-OF-WAY FENCE

616.1 Description

- (1) This section describes furnishing and erecting woven wire fence, chain link fence, or high tensile wire fence.

616.2 Materials

616.2.1 General

- (1) For the given materials, conform to the following:
 - Concrete [section 501](#)
 - Preservatives and preservative treatment [507.2](#)
 - Structural Steel and miscellaneous metals [506.2](#)
- (2) Furnish grade A, A-FA, A-S, A-T, A-IS, or A-IP concrete conforming to [501.2](#), except the engineer may waive the requirements for proportioning by weight, and may allow alternate mixers or mixing methods.

616.2.2 Woven Wire Fence Materials

616.2.2.1 Woven Wire Fabric

- (1) Furnish woven wire fabric composed of 11 gauge (3.05 mm) line and stay wires, except the top and bottom horizontal wires shall be 9-gauge (3.76 mm). This fabric shall have 10 line wires, a nominal height of 47 inches (1.20 m), and conform to the design the plans show. Run the vertical stay wires from top to bottom line wires, at 6 inch (150 mm) nominal spacing.
- (2) If the plans or special provisions do not designate a specific type of woven fence fabric, the contractor may use one of the following:
 - Zinc-coated steel conforming to AASHTO M 279 class 3.
 - Aluminum-coated steel conforming to ASTM A 584.
- (3) Furnish the same type for all fence fabric required under the contract, unless specified otherwise.

616.2.2.2 Barbed Wire

- (1) Furnish 15 1/2 gauge or heavier 2-strand coated steel barbed wire with 4-point coated steel barbs spaced not more than 5 inches (125 mm) apart and conforming to AASHTO M 280. If the plans or special provisions do not designate a specific type of barbed wire, the contractor may use one of the following:
 - Type Z zinc-coated steel.
 - Type ZA zinc-5 percent aluminum-mischmetal alloy coated steel.
 - Type A aluminum coated steel.
- (2) Furnish the same type for all barbed wire required under the contract, unless specified otherwise.

616.2.2.3 Smooth Wire

- (1) Furnish 9-gauge (3.76 mm) smooth zinc-coated steel wire for bracing and guying conforming to AASHTO M 279 class 3.

616.2.2.4 Braces

- (1) Furnish zinc-coated steel pipe or steel tubing braces conforming to ASTM A 53; or steel angle or channel section braces conforming to ASTM A 123. Use a type, minimum size, and minimum weight conforming to one of the following:
 - Welded or seamless steel pipe, nominal 1.90 inches (48.26 mm) outside diameter, weighing 2.72 pounds per linear foot (4.05 kg/m).
 - Steel tubing, 1.75 inches (44.45 mm) outside diameter, 3.13 pounds per linear foot (4.66 kg/m).
 - Steel angle section, nominal 1 3/4 x 1 3/4 x 1/4 inch (44.45 x 44.45 x 6.35 mm), 2.77 pounds per linear foot (4.12 kg/m).
 - Steel channel section, nominal 3 inches (76.2 mm), 4.1 pounds per linear foot (6.10 kg/m).
 - Other engineer-approved steel sections.
- (2) Shape brace ends as the plans show, or furnish with other engineer-approved fittings for anchoring to posts. Furnish fittings, bolts, nuts, washers or other hardware conforming to ASTM A 123.

616.2.2.5 Staples

- (1) Furnish 2-inch (50 mm) resin-coated staples made from 9-gauge (3.76 mm) zinc coated steel wire.

616.2.2.6 Posts

- (1) Furnish round wood posts manufactured from one of the softwood species listed in [614.2.4.1](#).
- (2) The posts shall conform to the dimensions the plans show with a tolerance of plus 2 inches (50 mm) for length, and a diameter at the top or small end, after peeling, 4 1/2 inches (115 mm) or greater for line posts and 6 inches (150 mm) or greater for corner, bracer, or vertical angle posts.
- (3) Use posts free from sap rot, woodpecker holes, plugged holes, pest-eaten areas, and hollow knots. Do not use posts with butt rot exceeding 5 percent of butt area. Ensure post tops are sound, except a 7 inch (175 mm) cedar post may have one pipe or heart rot 3/8 inch (10 mm) or smaller in diameter. Posts shall not have excessive checking or a one-way sweep greater than 3 inches (75 mm), or short kinks. Posts may have a winding twist unless unsightly and excessive. All knots shall be sound.
- (4) Do not use posts with both the maximum crook and maximum butt rot. Not more than 10 percent of the posts required under the contract may have the maximum crook or the maximum butt rot. The engineer will have sufficient grounds to reject posts that contain other defects of any kind that give a post an unsightly appearance.
- (5) Use posts that are seasoned in a department-approved manner and peeled for their entire length, with all outer and inner bark to the white wood completely removed by shaving or by other effective means. Trim knots closely and saw both ends of the post square. If setting the posts by driving, then the larger end may have a blunt point. After peeling, trimming, and cutting to required length, preservative treat the posts by the pressure process specified in [507.2.2.6](#), except the preservative minimum retention is 6 pounds per cubic foot (96 kg/m³) of wood for creosote-coal tar solution or pentachlorophenol solution.

616.2.3 Chain Link Fence Materials

616.2.3.1 General

- (1) Furnish new material for all parts. The department will not allow used, re-rolled, or open seam material in posts, rails, and braces.
- (2) All metal materials, except high strength steel posts, rails and braces, and ground rods must comply with AASHTO M 181, and the following:
 - Use type I zinc-coated steel or type II aluminum-coated steel tension wire.
 - Use type II aluminum-coated steel fence fabric.
 - Use type I zinc-coated steel.
 - Use type I zinc-coated steel rails and frames.
 - Use type I zinc-coated steel, cast iron, or malleable iron hardware and fittings.
 - Do not use AASHTO grade 2 steel posts, rails, or frames.
- (3) Unless specified otherwise, furnish the same type of material for all fence fabric required under the contract. Make all posts, hardware, and fittings used on the contract the same kind, unless specified otherwise.

616.2.3.2 Fence Fabric

- (1) Use fence fabric woven of 9-gauge (3.76 mm) wire in 2-inch (50 mm) diamond pattern mesh. Ensure the furnished fence fabric is the same nominal height as the designated fence height.

616.2.3.3 Posts

- (1) Use posts of the type, size, and length the plans show.
- (2) For standard strength posts, conform to ASTM F 1043 and use one of the following:
 - Group IA round steel pipe with a type A coating.
 - Group IIA roll-formed steel C-sections with a type A or C coating.
 - Group III hot rolled H beams with a type A coating.
- (3) For high-strength steel posts conform to ASTM F 1043 and use the following:
 - Group IC round steel pipe with a type C coating.

616.2.3.4 Post Tops

- (1) Fit all posts, except roll formed terminal posts, with ornamental tops of the type the plans show. Ensure ornamental tops are of department-approved design, made of metal, have a flanged base that fits snugly over top and around outside of post, and is securely fastened in place. Provide the base of each line post top with an opening for passage and support of the top tension wire.
- (2) For roll-formed line posts, the contractor may use the notched alternate post top the plans show instead of and ornamental post top.

616.2.3.5 Bracing

- (1) Use brace rail of the type, size, and weight the plans show for horizontal and diagonal bracing.
- (2) For standard strength bracing, conform to ASTM F 1043 and use one of the following:
 - Group IA round steel pipe with a type A coating.
 - Group IIA roll-formed steel C-sections with a type A or C coating.
- (3) For high-strength steel bracing conform to ASTM F 1043 and use the following:
 - Group IC round steel pipe with a type C coating.
- (4) Make horizontal and diagonal pipe, or roll formed braces and diagonal truss rods extend from all terminal, corner, intersection, or intermediate braced posts to the first adjacent line post, and fasten them securely to the posts with suitable connectors. Use zinc coated 3/8 inch (10 mm) round steel rods equipped with a threaded take-up adapter for diagonal truss rods.

616.2.3.6 Pipe Fittings

- (1) Use malleable iron, cast iron, or pressed steel pipe fittings.

616.2.3.7 Fabric Fasteners

- (1) Use clips made of 9-gauge (3.76 mm) zinc coated steel or 0.179-inch (4.55 mm) diameter aluminum tie wires as fasteners for securing the fence fabric to H column line posts. Use 9-gauge (3.76 mm) zinc coated steel or 0.179-inch (4.55 mm) diameter aluminum tie wires as fasteners for securing the fence to posts or top tension wires and braces. Use tie wires not smaller than 12-gauge (3.05 mm) zinc coated steel, or 0.149-inch (3.79 mm) diameter aluminum wire, as fasteners for securing to bottom tension wires.

616.2.3.8 Stretcher Bars

- (1) Use zinc-coated flat mild or rail steel of the required length.

616.2.3.9 Gates

- (1) Conform to the material, design, and dimensional requirements the plans show for chain link fence gates.

616.3 Construction

616.3.1 General

- (1) If an area of right-of-way is subject to ingress of cattle or other farm animals, erect the right-of-way fencing before starting other items of work under contract for these areas, or provide a temporary fence to exclude the livestock.
- (2) Remove and dispose of all trees, brush, logs, stumps or other debris that might interfere with fence construction, within approximately 12 inches (300 mm) along each side of the fence line, as specified for clearing and grubbing in [201.3](#). If the contractor cuts trees or stumps close enough to the ground to prevent interference with correct fence erection, the engineer will not require grubbing of the stumps.
- (3) Excavate minor ridges and humps in the ground surface, necessary to correctly erect the fence.
- (4) Erect the fence on the right-of-way, parallel to, and 3 feet (0.9 m) from the right-of-way line, unless the plans show or the engineer directs otherwise. Where the engineer directs or allows the contractor to leave trees on the fence line, deviate the fence line past the tree as the plans show.
- (5) Erect the wire on the far side of the posts with respect to the proposed roadway.
- (6) Before final acceptance, remove and dispose of all excess excavation and surplus materials from the fence site.

616.3.2 Woven Wire Fence

616.3.2.1 General

- (1) Erect woven wire fencing fabric and one line of barbed wire on preservative treated wood posts. Place all end, corner, pull, and vertical angle posts at the locations staked or where the engineer designates.

616.3.2.2 Placing Posts

- (1) Set all posts with the large end down to the depth the plans show and make plumb and true to line on the wire side. Unless the plans show otherwise, set line posts at as uniform spacing as possible under local conditions, but the spacing shall not exceed 16 feet (5 m) center to center of posts. Set additional posts, as required, at abrupt changes in grade. Excavate post holes to the required depth. If the contractor encounters rock, employ necessary drilling, blasting, or other means of excavation. Use suitable material for backfill, and place and compact in layers around the post until firmly embedded, plumb, and true to alignment.
- (2) Set all corner, end, pull, vertical angle posts, and posts at stream crossings in concrete. Brace and guy as the plan details show. Use a double strand of 9-gauge (3.76 mm) zinc-coated, smooth wire for wire guying and stretch between posts as the plans show. Wrap the wire around the posts and staple. Twist the strands of wire taut. Place vertical angle post assemblies at grade change points of more than 2 feet (600 mm) between consecutive posts that result in a wire uplift on the posts.
- (3) The contractor may drive posts instead of setting posts in previously dug holes and backfilling, except if placing in concrete. If driving posts, drive them plumb, to the required depth and alignment, and with adequate lateral stability. Remove and replace with a sound post any post not conforming to the above requirements, or damaged below cut-off during driving.

616.3.2.3 Placing Wire

- (1) Attach the woven wire to the posts so that the bottom wire is approximately 2 inches (50 mm) above the ground, but not more than 4 inches (100 mm) above the ground at the posts, except on abrupt grade changes as the plans show. Place one line of barbed wire above the woven wire, as the plans show, and staple the wire at each post.
- (2) Secure the woven wire and the barbed wire to all end and corner posts by wrapping each line of wire around the post and tying the wire back on itself with not less than 1 1/2 twists tightly wrapped with tools designed for the purpose, and supplement with staples driven into the posts. Stretch the wire until no slack exists, longitudinal wires are tight, and approximately 50 percent of the factory fabricated fence crimp is removed. Apply tension with an engineer-approved stretcher designed to produce a uniform amount of tension in each wire.
- (3) Secure the woven wire to each post with staples at the top and bottom wires and, at least, at 3 intermediate wires. Use additional staples if necessary. Stagger the vertical alignment of staples slightly and do not place parallel with the wood grain. Drive the staples tight at all pull, angle, end, and corner posts, and double staple the wire if required. Drive the staples firmly at other line posts but loose enough to allow lateral movement of the wire. Make splices in the fencing at posts or between posts to the engineer's satisfaction.
- (4) Ground the fence as specified in [616.3.3](#).

616.3.3 Chain Link Fence

616.3.3.1 General

- (1) Erect chain link fencing fabric, of the required height, attached at the top and bottom to a tension wire, on driven unbraced metal line posts.

616.3.3.2 Setting Posts

- (1) Set or drive posts, in a vertical position, at the required location and alignment, and at as uniform a spacing as local conditions allow. Space posts, center to center, according to the following situations as follows:
 - On a tangent or on a curve of 500 feet (150 m) or more radius; space posts at no more than 10 feet (3 m).
 - On a curve of from 200 feet (60 m) to 500 feet (150 m) radius, space posts at no more than 8 feet (2.4 m).
 - On a curve of from 100 feet (30 m) to 200 feet (60 m) radius, space posts at no more than 6 feet (1.8 m).
 - On a curve of less than 100 feet (30 m) radius, space posts at no more than 5 feet (1.5 m).

- (2) Set or drive posts, with their tops at the required elevation to provide a smooth profile at the top wire without abrupt changes. Conform to the general contour of the terrain.
- (3) Place an end post at each end of each run of fence. Place a corner post at breaks of 30 degrees or more in the horizontal alignment. Set an intersection post in line with an intersecting chain link fence, and brace with the adjacent post of the intersecting fence.
- (4) Place an intermediate braced post if there is over a 5 degrees change in the vertical alignment or a change in the fence line grade of greater than 9 percent that results in wire uplift on the post.
- (5) If placing posts on concrete walls, curbs, or other concrete structures, place them in sleeve anchors and grout as the plan details show. Use a non-shrink grout conforming to [506.3.30](#) for bearings and anchorages. Thoroughly ram the grout into the sleeve anchor while the post is in place. Allow the grout to cure at least 48 hours before stretching the chain link fabric.
- (6) Coat the portion of aluminum-coated posts to be set in concrete with a uniform, thin application of asphaltic or other engineer-approved material. Ensure this coating is firmly set before placing the posts.
- (7) Set the end, corner, angle, intersection, and intermediate braced posts in concrete footings.
- (8) Ensure the top of the concrete footing is approximately 6 inches (150 mm) below the ground line and slopes slightly away from the post. Locate the footing to allow centering of the post. Backfill the top of the footing with topsoil or other suitable material.
- (9) In firm ground, excavate holes for the footings to the neat dimensions and place concrete directly in the excavation. Remove rock or other obstructions encountered in the excavation to the required depth.
- (10) If unstable soils or other areas prevent making footing excavations to neat dimensions, use forms. Keep the form in place until the concrete cures for at least 24 hours. After removing the form, backfill the footing with suitable material. Ensure the backfill material has the correct moisture content for compacting and place and compact in layers.
- (11) Set the posts, anchor the braces in place, and cure concrete footings for at least 7 days before placing the top and bottom tension wires.
- (12) Place an intermediate braced post midway between end posts and corner posts if the fence run is more than 1000 feet (300 m), but not more than 2000 feet (600 m). For fence runs greater than 2000 feet (600 m), make the maximum spacing of intermediate braced posts 1000 feet (300 m).
- (13) Set in concrete or drive unbraced line posts, provided the contractor drives them plumb, to the required depth and alignment, and with adequate lateral stability. Remove and replace any post that fails to conform to the above requirements, or that the contractor damages during driving, with an undamaged post. In unstable soils, increase the length of driven posts by multiples of 2 feet (600 mm), as the engineer directs, to increase the stability of the post.

616.3.3.3 Erecting Fence Fabric

- (1) Place, tension, and secure the top and bottom tension wires before erecting the fence fabric. Anchor the tension wires securely to each end, corner, intersection, or intermediate braced post. Fasten the tension wires to each line post.
- (2) Attach the end of the fabric to the post with a stretcher bar threaded through the end loops of the fabric and secured to the post with clamps and bolt. Stretch the fabric with engineer-approved stretching equipment to remove all slack. Secure the stretched fabric to line posts, braces, and tension wires with specified fabric fasteners. Place fabric fasteners on line posts at no greater than 14 inch (350 mm) centers; and on braces and tension wires at no greater than 18 inch (450 mm) centers. Repeat stretching operations at approximately every 100 feet (30 m) for each run of fence.
- (3) Splice fabric by interweaving a wire picket through each end loop of each piece of fabric. Ensure that the splice is neat and secure.

616.3.3.4 Gates

- (1) Erect chain-link fence gates as the plans show.

616.3.3.5 Salvaged Chain Link Fence

- (1) Remove, handle, store and re-erect the fence, gates, and all posts, fittings, bases and appurtenant hardware without damaging the parts. Replace contractor damaged parts and provide all other materials, including concrete, required to re-erect the fence. Dispose of all surplus materials.

- (2) Re-erect salvaged chain link fence as specified for chain link fence under [616.3.3](#).

616.3.4 High Tensile Wire Fence

- (1) Construct tensioned wire strands on preservative treated wood posts as the plan details show. Furnish bracing materials as specified in [616.2.2.4](#). Use wood posts of the size the plans show and otherwise conforming to [616.2.2.6](#).

616.3.5 Electrical Grounds

- (1) Ground woven and high tensile wire fence. Use 1/2 inch (13 mm) minimum diameter zinc coated or copper clad steel rod at least 8 feet (2.5 m) long, driven vertically into the ground along the fence line, near a post, until approximately 6 inches (150 mm) extends above the ground. Securely clamp, bolt, or braze at least 3 fence wires to the ground rod. Electrically ground barbed wire as the plans show.
- (2) Install electrical grounds at locations where primary electrical transmission or distribution lines, other than secondary feeder lines for individual service, cross the fence. Install one ground rod along the fence at the point of crossing and one 25 to 50 feet (7.5 to 15 m) in each direction from the crossing.
- (3) Install additional ground rods in each fence spaced approximately every 500 feet (150 m). Install at least one ground rod on each electrically isolated section of fence, defined as a run with no interruptions in electrical continuity.

616.4 Measurement

- (1) The department will measure the Fence Woven Wire and Fence High Tensile Wire bid items by the linear foot acceptably completed, measured from center to center of end posts, along the fence line at the ground line. The department will deduct for openings.
- (2) The department will measure the Fence Chain Link bid items by the linear foot acceptably completed, measured from center to center of end posts, along the top tension wire. The department will deduct for gates and other openings.
- (3) The department will measure the Gates Chain Link bid items as each individual unit acceptably completed.
- (4) The department will measure the Fence Chain Link Salvaged bid items by the linear foot acceptably completed, measured from center to center of end posts, including gates, along the top rail or tension wire.

616.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
616.0100	Fence Woven Wire (height)	LF
616.0200 - 0299	Fence Chain Link (height)	LF
616.0329	Gates Chain Link (width)	EACH
616.0400 - 0499	Fence Chain Link Salvaged (height)	LF
616.0500	Fence High Tensile Wire (height)	LF

- (2) Payment for all bid items under this section includes erecting temporary fence to keep farm animals off the right-of-way.
- (3) Payment for all the fence bid items under this section is full compensation for clearing and grubbing the fence line; for excavating; for setting posts including placing concrete; for erecting and tensioning all fencing components; for installing grounds; and for removing and disposing of all debris, excess excavation, and surplus materials.
- (4) Payment for the Fence Chain Link bid items also includes providing longer posts driven in unstable soils at no additional cost to the department.
- (5) Payment for the Fence Chain Link Salvaged bid items also includes removing, handling, and storing existing fence materials; for re-erecting gates; for replacing all contractor damaged parts; and for providing all other materials required to re-erect the fence.
- (6) Payment for the Gates Chain Link bid items is full compensation for providing the gate.

SECTION 617 HAULING

617.1 Description

- (1) This section describes transporting materials from the point of supply to the work site.

617.2 (Vacant)

617.3 Construction

- (1) Haul materials from the pit, crushing plant, quarry, railroad car, or other material source to the work site in an engineer-approved vehicle. The engineer may approve any size or type of vehicle for hauling provided that vehicle conforms to the following:
1. Applicable legal restrictions imposed by other jurisdictions as specified in [107.1](#).
 2. For material specified for measurement by volume in the vehicle, the provisions of [109.1.3](#).
- (2) Conform to additional hauling requirements specified under the individual bid items for the material being hauled.
- (3) Unless the contract specifies otherwise, build and maintain private roads, bridges, culverts, and structures as necessary to reach the work site from the material source. Also, maintain, repair, and restore previously constructed private roads, bridges, culverts, and structures used to pre-hauling condition.

617.4 Measurement

- (1) The department will measure the Hauling bid items by the cubic yard mile (CYMI) acceptably completed. The department will determine the total quantity for payment by multiplying the number of cubic yards hauled and placed in each zone by the mile number of the zone. The department will determine mile zones along the shortest and most practical line of haul from the loading point to and along the project. The department will only measure hauling of materials specifically included in a Hauling bid item.

617.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
617.0100	Hauling (material)	CYMI

- (2) Payment for the Hauling bid items is full compensation for hauling the specified materials and, unless the contract specifies otherwise, costs associated with private roads, bridges, culverts, and structures used to haul material under this bid item.
- (3) If the contract does not include the Hauling bid item, all hauling is incidental to the related work. Hauling materials not specifically included in a Hauling bid item is also incidental to related work.

SECTION 618 MAINTENANCE AND REPAIR OF HAUL ROADS

618.1 Description

- (1) This section describes maintaining, repairing, and restoring all public roads, streets, drainage facilities, and other components used as a designated detour or for hauling by contractor, subcontractor, or supplier to support work for a department contract to its pre-haul condition. Public roads and streets shall be limited to those not a part of the State Trunk Highway System and from now on called haul roads.
- (2) The contractor's obligation under this bid item does not authorize the use of haul roads for transporting loads exceeding statutory size and weight limitations.

618.2 Materials

- (1) Furnish and use materials in the work that are at least equal in quality and serviceability to those existing in the road before its use as a haul road. The engineer will determine the amount, quality, and acceptability of all materials.

618.3 Construction

618.3.1 General

- (1) The engineer will determine the type and quality of maintenance and repair required, including the quality of materials used. If 2 or more contractors having contracts with the department transport materials over the same haul road at the same time, or at about the same time, the engineer will determine the repair and restoration obligations of the respective contractors.

618.3.2 Maintenance

- (1) The engineer has the authority to order maintenance and repair work on haul roads, including dust abatement, at any time during hauling operations, as necessary to ensure reasonable service to other users of the road.
- (2) To prevent or minimize damage to haul roads the contractor may stabilize, reinforce, or strengthen existing facilities before hauling starts; and may condition the surface and perform repairs during hauling operations.

618.3.3 Restoration

- (1) Upon termination of hauling operations and before final acceptance, restore all haul roads, including drainage facilities and other components, to the equivalent of pre-hauling conditions.
- (2) The final repair of a haul road is subject to the engineer's approval.

618.4 Measurement

- (1) The department will measure the Maintenance and Repair of Haul Roads bid items as each individual unit acceptably completed.

618.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
618.0100	Maintenance and Repair of Haul Roads (project)	EACH

- (2) Payment for the Maintenance and Repair of Haul Roads bid items is full compensation for providing, hauling and placing required materials; and for other costs incurred by the contractor to prevent or minimize damage to the haul roads.
- (3) The department will pay for this item upon completion of all work under the contract, except the engineer may make partial payment for work performed.
- (4) If the engineer determines that no hauling occurred, or that hauled loads caused no damage to a haul road, the department may omit this bid item.

SECTION 619 MOBILIZATION

619.1 Description

- (1) This section describes the work and operations necessary to move personnel, equipment, supplies, and incidentals to the project site and to establish all of the contractor's offices, buildings, sanitary accommodations, and other facilities necessary to work on the project. It also includes all other work and operations whose performance is required, or for costs necessarily incurred before beginning work on various items on the project site.

619.2 (Vacant)

619.3 (Vacant)

619.4 Measurement

- (1) The department will measure Mobilization as each individual unit acceptably completed.

619.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
619.1000	Mobilization	EACH

- (2) Payment for Mobilization is full compensation for supplying and providing all materials, facilities, and services, and for performing all work necessary to complete this contract bid item.
- (3) The department will pay the contract each unit to the contractor according to the following schedule:
- If the contractor earns 5 percent or more of the original contract amount, the department will pay 25 percent of the amount bid under the Mobilization bid item.
 - If the contractor earns 25 percent or more of the original contract amount, the department will pay 50 percent of the amount bid under the Mobilization bid item.
 - If the contractor earns 50 percent or more of the original contract amount, the department will pay 75 percent of the amount bid under the Mobilization bid item.
 - If the contractor earns 75 percent or more of the original contract amount, the department will pay 100 percent of the amount bid under the Mobilization bid item.
- (4) If the contract does not include a separate Mobilization bid item, the work necessary for mobilization is incidental to work included under other contract bid items.

SECTION 620 CONCRETE CORRUGATED MEDIAN AND CONCRETE MEDIAN NOSE

620.1 Description

- (1) This section describes constructing a concrete corrugated median or concrete median nose placed in one course on a prepared foundation.

620.2 Materials

- (1) Use materials conforming to the requirements for the class of material named and specified below.
 - Concrete [section 501](#)
 - Joint filler [415.2](#)
 - Reinforcement [section 505](#)
- (2) Furnish grade A, A-FA, A-S, A-T, A-IS, or A-IP concrete conforming to [501.2](#).

620.3 Construction

- (1) The engineer will inspect concrete built under section 620 for transverse cracking as specified in [415.3.19](#) for ancillary concrete. Repair cracked concrete as the engineer directs.
- (2) Under the Concrete Corrugated Median bid item, construct concrete corrugated median including nose section, placed in one course on a prepared foundation.
- (3) Under the Concrete Median Blunt Nose bid item, construct a blunt concrete median nose section.
- (4) Under the Concrete Median Sloped Nose bid item, construct a sloped concrete median nose section.

620.3.1 Preparing the Foundation

- (1) Prepare the foundation for the median by excavating to the lines, grade, and cross section the plans show and required for placing the concrete. Remove and replace any soft or unsuitable material encountered with suitable material and thoroughly compact and finish the foundation to a firm surface. Ensure the foundation is moist when placing the concrete.

620.3.2 Placing Concrete

- (1) If forms are required, set them to line and grade and secure in place before placing the concrete.
- (2) Deposit the concrete to the proper depth, consolidate by spading or vibrating, and strike off at the required elevation and crown. Form the required corrugations with tools and equipment appropriate for the purpose, according to the plan details.
- (3) If constructing the median adjacent to concrete pavement, place tie bars as specified under [415.3.9.1](#) and [415.3.9.2](#) for longitudinal and transverse joints.
- (4) Broom finish the surface of the median unless specified otherwise. Draw the broom transversely across the full width of the median surface with adjacent strokes slightly overlapping. Perform brooming in a manner that produces corrugations uniform in appearance and not greater than 1/8 inch (3 mm) deep. Complete the brooming before the concrete's condition causes the surface to tear or become rough from the operation. Provide a finished surface free from rough or porous areas, irregularities, and depressions resulting from improper broom handling. Ensure brooms are the quality, size, and construction appropriate for the job and operated to produce a surface finish meeting the engineer's approval.
- (5) Cure the concrete as specified for concrete pavement in [415.3.12](#).
- (6) If constructing concrete median during cold weather then conform to [415.3.15](#) for cold weather concreting.
- (7) Conform to [415.3.16](#) for protection of concrete median.
- (8) Remove and dispose of all excavation and surplus materials in the manner specified for in [205.3.12](#).

620.4 Measurement

- (1) The department will measure Concrete Corrugated Median by the square foot acceptably completed, including the nose section.
- (2) The department will measure Concrete Median Blunt Nose and Concrete Median Sloped Nose by the square foot acceptably completed, for the nose section only.

620.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
620.0100	Concrete Corrugated Median	SF
620.0200	Concrete Median Blunt Nose	SF
620.0300	Concrete median Sloped Nose	SF

- (2) The department will adjust pay for crack repairs on concrete built under section 620 as specified in [416.5.2](#) for ancillary concrete.
- (3) Payment for Concrete Corrugated Median, Concrete Median Blunt Nose, or Concrete Median Sloped Nose is full compensation for preparing the foundation; for providing all materials, including concrete, joint filler and tie bars; for hauling, placing, consolidating, shaping, finishing, curing and protecting the concrete; and for disposing of surplus materials.

SECTION 621 LANDMARK REFERENCE MONUMENTS

621.1 Description

- (1) This section describes constructing landmark reference monuments, with or without covers.

621.2 Materials

- (1) Furnish materials conforming to the following:

Concrete	section 501
Reinforcement	505.2
Miscellaneous metals	506.2.3
Brick and concrete brick or block masonry	519.2
Mortar	519.2.3

- (2) Use castings used for cast iron covers conforming to [611.2](#) for castings.
- (3) Make aluminum monuments and monument covers from an aluminum and magnesium alloy as the manufacturer determines.
- (4) Furnish grade A, A-FA, A-S, A-T, A-IS, or A-IP concrete conforming to [501.2](#). The engineer may waive the requirements for proportioning by weight, and may allow mixers or mixing methods other than those specified, provided the contractor demonstrates the production of a concrete mixture equal in quality to that produced by equipment and methods specified for concrete in [section 501](#).

621.3 Construction

621.3.1 Monument Location

- (1) Preserve in their original position all landmarks within the construction limits of the work under contract and that require reference monuments until construction and marking of the landmark reference monuments.
- (2) In general, construct monuments in the landmark's near vicinity, outside the construction limits of the work under contract, and at the exact locations, the engineer determines. However, if the contract specifies or the engineer directs, construct monuments at the exact locations of, and to replace, landmarks disturbed by the construction.

621.3.2 Placing Monuments

621.3.2.1 General

- (1) Under the Landmark Reference Monuments bid item, construct cast in place or precast reinforced concrete monuments or aluminum monuments in holes excavated in the ground or, in the case of type C aluminum monuments, driven into the ground.
- (2) Place a department-furnished metal marker on all monuments, except aluminum monuments. Place a contractor-furnished metal marker, conforming to plan details, on all aluminum monuments.
- (3) Except if driving aluminum monuments, place or construct the monuments in holes excavated in the ground. Make the holes the size and depth the plans show or as the engineer directs.
- (4) Remove and dispose of all surplus excavation and materials as specified in [205.3.12](#).

621.3.2.2 Cast In Place Concrete Monuments

- (1) Fill holes with concrete and strike off flush with the ground surface. Place a steel reinforcement rod in the concrete as the plans show. Place the metal marker while the concrete is still plastic.

621.3.2.3 Precast Concrete and Non-Driven Aluminum Monuments

- (1) Level and thoroughly compact the bottom of the holes at the proper elevation. Place the monument and backfill with suitable material and thoroughly compact in 6-inch (150 mm) layers.

621.3.2.4 Aluminum Drive-In Monuments

- (1) If the plans or the engineer specifies aluminum drive-in monuments for use in unstable soils, drive the monuments into the ground to the minimum depth the plans show and drive the top flush with the surface.
- (2) Increase the depth as the engineer directs to obtain a suitable foundation for the monument.

621.3.2.5 Monument and Cover

- (1) Under the Landmark Reference Monuments and Cast Iron Covers and Landmark Reference Monuments and Aluminum Covers bid items, construct cast in place or precast reinforced concrete monuments in holes excavated in the ground and covered with cast iron covers or, if specified, aluminum monuments excavated or driven into the ground and covered with aluminum covers.
- (2) Construct cast in place or precast concrete monuments or aluminum monuments as specified in the above subsections, except as follows:
 - Place 12 inches (300 mm) of granular backfill to an elevation at least 3 inches (75 mm) below the top of concrete monuments according to plan details.
 - If using cast in place concrete monuments, form at least the top 3 inches (75 mm) of the monument.
- (3) Place and adjust the cover as specified in [section 611](#).

621.3.3 Protecting and Curing

- (1) Cure cast in place concrete monuments for 72 hours by one of the methods specified for concrete pavement in [415.3.12](#).
- (2) Protect placed concrete monuments as specified for concrete pavement in [415.3.16](#)
- (3) Protect cast in place concrete monuments from freezing for 7 days.

621.4 Measurement

- (1) The department will measure Landmark Reference Monuments, Landmark Reference Monuments and Cast Iron Covers, and Landmark Reference Monuments and Aluminum Covers as each individual unit acceptably completed.

621.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
621.0100	Landmark Reference Monuments	EACH
621.1100	Landmark Reference Monuments and Cast Iron Covers	EACH
621.1200	Landmark Reference Monuments and Aluminum Covers	EACH

- (2) Payment for Landmark Reference Monuments, Landmark Reference Monuments and Cast Iron Covers, and Landmark Reference Monuments and Aluminum Covers is full compensation for all excavating; for providing, placing, curing and protecting concrete; for providing and placing aluminum monuments, including markers; for providing and placing steel rod; for placing department furnished markers; for providing, placing and adjusting iron or aluminum covers; for providing, if necessary, placing and compacting backfill material; and for disposing of surplus materials.
- (3) The department will not pay for the increased depth of monument if the engineer directs this to obtain suitable foundation.

SECTION 623 DUST CONTROL SURFACE TREATMENT

623.1 Description

- (1) This section describes applying dust control surface treatment to aggregate bases, shoulders, and other drivable surfaces.

623.2 Materials

623.2.1 General

- (1) Furnish either magnesium chloride or calcium chloride in either a liquid or a solid state. Furnish solutions that are stable and have less than 1 percent sediment falling out of solution below 0 F (-18 C).
- (2) Provide a certified report of test or analysis from the manufacturer or supplier certifying chemical composition. The department will accept material based on those certifications as specified in [106.3.3](#).

623.2.2 Magnesium Chloride

- (1) Furnish liquid solutions containing 30 percent or more magnesium chloride by weight, less than 1 percent calcium chloride by weight, and less than 1 percent sodium chloride by weight.
- (2) Furnish solid containing 47 percent or more magnesium chloride by weight, less than 1 percent calcium chloride by weight, and less than 1 percent sodium chloride by weight.

623.2.3 Calcium Chloride

- (1) Furnish liquid solutions containing 38 percent or more calcium chloride by weight, less than 1 percent magnesium chloride by weight, and less than 1 percent sodium chloride by weight.
- (2) Furnish solid containing 77 percent or more calcium chloride by weight, less than 1 percent magnesium chloride by weight, and less than 1 percent sodium chloride by weight.

623.3 Construction

- (1) The contractor is responsible for dust control on the project as specified in [107.18](#). Treat vulnerable areas of the project as necessary to control dust from construction equipment and public traffic. Consult with engineer before applying dust control chemical. Apply chemical treatment as the engineer directs.
- (2) Arrange to have available, within 24 hours of receiving notice from the engineer, a sufficient supply of dust control chemical to treat those areas of the project that are vulnerable at any time during construction. Also, provide, within the same 24 hours, sufficient spreading equipment to apply the chemical. Provide spreading equipment capable of applying the dust control chemical, uniformly and without runoff, over the treated surface at the specified application rate.
- (3) After shaping and compacting the surface to be treated, apply a sufficient amount of water to penetrate at least 2 inches (50 mm). After this pre-wetting and while the surface is still moist but not muddy, apply the required amount of chemical uniformly over that surface at the following rate:
 1. For liquids, 0.33 gallons or more/square yard (1.5 L/m²). Do not exceed 0.50 gallons/square yard (2.3 L/m²).
 2. For solids, 1.5 pounds or more/square yard (7.3 kg/m²). Do not exceed 2 pounds/square yard (9.8 kg/m²).
- (4) Do not apply dust control chemical in the rain, when the official weather bureau forecasts rain within 24 hours, or under other conditions that might result in a significant loss of material.

623.4 Measurement

- (1) The department will measure Dust Control Surface Treatment by the square yard acceptably completed. The engineer may calculate the yardage using volume or weight and applying a conversion factor.

623.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid item:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
623.0200	Dust Control Surface Treatment	SY

- (2) Payment for Dust Control Surface Treatment is full compensation for providing the dust control treatment and pre-wetting water.

SECTION 624 WATER

624.1 Description

- (1) This section describes furnishing, hauling, and applying water to compact embankments and base, re-compacting existing base, or dust control within the right-of-way.

624.2 Materials

- (1) Use water that is reasonably clean and free of harmful materials.

624.3 Construction

- (1) Haul and apply water using vehicles equipped with watertight tanks. Equip the tanks with a suitable pressure-type distributor device that allows uniform application over the specified area. Use tanks with a minimum capacity of 1000 gallons (3700 liters) and equipped with positive shut-off valves controlled while the vehicle is in motion.
- (2) Uniformly apply the water and incorporate in the manner and amounts, at the times, locations, and purposes that the engineer orders or allows. Load and unload the tank and operate the equipment in a manner that does not waterlog or damage the subgrade or base.

624.4 Measurement

- (1) The department will measure Water by the thousand gallon units (MGAL). The quantity measured equals the amount of water furnished and applied as the engineer directs according to the contract. The department will determine the volume by engineer-approved meters, or from tanks of known capacity.

624.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
624.0100	Water	MGAL

- (2) Payment for Water is full compensation for providing, hauling, and applying or incorporating the water.
- (3) If the contract does not contain the bid item Water, then furnishing and applying water is incidental to other items of work.

SECTION 625 TOPSOIL AND SALVAGED TOPSOIL

625.1 Description

- (1) This section describes furnishing, placing, spreading and finishing humus-bearing soil, adapted to sustain plant life, commonly known as topsoil, from locations the contractor furnishes beyond the limits of the right-of-way.
- (2) This section also describes removing topsoil from the sites of proposed roadway excavations and embankments in amounts and depths available and necessary to cover the work slopes. This work also includes reclamation, placing, spreading, and finishing of this topsoil.

625.2 Materials

- (1) Topsoil consists of loam, sandy loam, silt loam, silty clay loam or clay loam humus-bearing soils adapted to sustain plant life, and ensure this topsoil is in a Ph range of 6.0 to 7.0.
- (2) Salvaged topsoil consists of the loam, sandy loam, silt loam, silty clay loam or clay loam humus-bearing soils available from overlying portions of areas to be occupied by the completed roadway.

625.3 Construction

625.3.1 Preparing the Roadway for Topsoil

- (1) Undercut or underfill all areas designated to receive topsoil to a degree that if covered to the required depth with topsoil the finished work conforms to the required lines, grades, slopes and cross sections the plans and drawings show.

625.3.2 Processing Topsoil or Salvaged Topsoil

- (1) Mow topsoil procurement areas to a height of approximately 6 inches (150 mm). Remove litter such as brush, rock, and other materials that will interfere with subsequent vegetation establishment.
- (2) Strip off the humus-bearing soil. Take care to minimize removing the underlying sterile soil. Then stockpile the topsoil on the right-of-way or place it directly on the designated areas.
- (3) Under the Salvaged Topsoil bid item, remove topsoil from excavation areas and the roadway foundation up to the quantity necessary to cover the slopes for the bid items of Salvaged Topsoil and Topsoil. Salvage topsoil from embankment areas outside the roadway foundation only if that additional material is required to cover the slopes.
- (4) Use Salvaged Topsoil in excess of the contract quantity to replace contract quantities of Topsoil. Utilize excess topsoil on the project or dispose of as specified in [205.3.12](#).

625.3.3 Placing

- (1) After preparing and finishing the areas designated for topsoil to the required lines, grades, slopes and cross section, place and spread the topsoil to a uniform depth as the plans show or required in the contract. If no depth is shown, place and spread the topsoil to a minimum depth of 4 inches (100 mm) in rural areas and a minimum depth of 4 inches (150mm) in urban areas, or as the engineer designates.
- (2) Break down all clods and lumps using the appropriate equipment to provide a uniformly textured soil.
- (3) In urban or other areas if a lawn type turf is wanted, ensure 100 percent of the topsoil passes a one inch (25 mm) sieve and at least 90 percent passes the No. 10 (2.00 mm) sieve.
- (4) Remove rocks, twigs, foreign material, and clods that cannot be broken down. Dress the entire surface to present a uniform appearance. The engineer will not require rolling.
- (5) If light sandy soils are covered with heavier clay bearing loam topsoil, then mix or blend the 2 types of soils to a more or less homogeneous mixture by using the appropriate equipment.

625.4 Measurement

625.4.1 Topsoil

- (1) The department will measure Topsoil acceptably completed by the square yard or by the cubic yard, whichever the contract specifies.
- (2) If the department measures by the square yard, the measured quantity shall equal the actual number of square yards of topsoiled area to the depth specified within the limits of construction designated on the plans, or in the contract, or as the engineer directs.

- (3) If measured by the cubic yard, the department will measure material in the vehicle. If the contractor transports the material in vehicles not adapted for measurement, then the department will measure the material in cubic yards of volume in its original position computed by the method of average end areas with no correction for curvature; or if the engineer directs, by the method of truncated prisms.

625.4.2 Salvaged Topsoil

- (1) The department will measure Salvaged Topsoil by the square yard acceptably completed. The quantity measured for payment shall equal the actual number of square yards of area topsoiled to the depth specified within the limits of construction designated on the plans or in the contract, or as the engineer directs.

625.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
625.0100	Topsoil	SY
625.0105	Topsoil	CY
625.0500	Salvaged Topsoil	SY

625.5.1 Topsoil

- (1) Payment for Topsoil is full compensation for providing, excavating, loading, hauling, and placing this material; and for undercutting excavations, or underfilling embankments necessary to receive this material. The department will make no allowance, adjustment, or measurement for payment under the Excavation bid items for undercutting cut sections, or underfilling embankments.

625.5.2 Salvaged Topsoil

- (1) Payment for Salvaged Topsoil is full compensation for removing, stockpiling, reclaiming, hauling, and placing this material; and for undercutting excavations, or underfilling embankments necessary to receive this material. The department will make no deductions from the Excavation bid items for the quantities of Salvaged Topsoil material obtained from areas of cut sections. Additionally, the department will not measure or pay for the volumes of Salvaged Topsoil removed from sites of proposed embankments under the Excavation bid items, or make any allowance, adjustment, or measurement for payment under the Excavation bid items for undercutting cut sections, or underfilling embankments.
- (2) The contractor shall restore areas of salvaged topsoil washed out or damaged due to erosion after partial acceptance of the salvaged topsoil, and all associated erosion control work. The department will pay for restoring these areas at a unit price determined by multiplying the contract unit price bid for Salvaged Topsoil by 3. The department will pay for restoration under the Restoration Post Acceptance Salvaged Topsoil administrative item.
- (3) The department will not pay for removing topsoil from outside the roadway foundation in embankment areas unless that material is necessary to cover the slopes.

SECTION 626 PEAT HUMUS

626.1 Description

- (1) This section describes selecting portions of the material obtained under the Excavation Marsh bid item under the contract, or stored under a previous contract, and incorporating it into the surfaces of portions of the roadway.

626.2 Materials

626.2.1 If Marsh Excavation is an Item in the Contract

- (1) The contractor shall select those portions of material encountered under the Excavation Marsh bid item that contain the more fibrous material consisting of decomposed vegetable matter, moss, etc from the more or less purely muck-like substances. Take this material from marshes the plans or the contract indicates as having suitable material, to the extent that it is available or necessary for the work intended. Place the selected material into piles separate and apart from the waste materials encountered. Locate and size these piles of selected material to ensure proper drainage, and ready and convenient handling when incorporating into the work.

626.2.2 If Marsh Excavation is Not an Item in the Contract

- (1) If stored under a previous contract, this material consists of the available quantities and character of material stored and made available to the contractor under the contract.

626.3 Construction

626.3.1 General

- (1) Produce a layer approximately 6 inches (150 mm) deep of a uniform mixture of the native soil and the material previously designated. Cover the selected areas with a layer of marsh excavation material approximately 3 to 4 inches (75 to 100 mm) deep, dependent upon its consistency and moisture content, and incorporate it into the native soil by the appropriate equipment to accomplish the above-required results. After completing mixing operations, smooth and dress the surfaces to restore them to the required lines, grades, slopes, and cross section.

626.3.2 Disposing of Surplus Material

- (1) Dispose of any remaining stockpiled material as specified in [205.3.7](#) for marsh excavation and disposal.

626.4 Measurement

- (1) The department will measure Peat Humus by the square yard acceptably completed. The quantity measured shall equal the actual number of square yards of area this material was placed on, and incorporated into, according to the contract, within the limits of the construction the plans show, or in the contract, or as the engineer directed.

626.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
626.0200	Peat Humus	SY

- (2) Payment for Peat Humus is full compensation for selecting, stockpiling, reclaiming, loading, hauling, placing, and incorporating in the soil; for subsequent restoring of the surface, and disposing of surplus material; provided, that the department makes no deductions from the Excavation Marsh bid item for the quantities of materials salvaged or reclaimed from for the bid item of Peat Humus.

SECTION 627 MULCHING

627.1 Description

- (1) This section describes furnishing, placing, and anchoring a mulch cover, usually in connection with seeding the surfaces of the roadway.

627.2 Materials

- (1) Mulching material consists of straw or hay in an air-dry condition, wood excelsior fiber, wood chips, or other suitable material of a similar nature that the engineer approves, and is substantially free of noxious weed seeds and objectionable foreign matter.
- (2) If using tackifier, the department will prequalify it before use. Select tackifiers from the department's erosion control product acceptability list (PAL). The contractor may obtain a copy of the PAL and the prequalification procedure for products not on the PAL from the department.

627.3 Construction

627.3.1 General

- (1) Unless directed otherwise, place the mulch on the specified area within 2 days after completing the seeding.
- (2) The contractor shall not perform mulching during periods of excessively high winds that might preclude proper mulch placement.
- (3) Place the mulch loosely or open enough to allow some sunlight to penetrate and air to slowly circulate, but thick enough to shade the ground, conserve soil moisture, and prevent or reduce erosion.
- (4) Maintain the mulched areas and repair all areas damaged by wind, erosion, traffic, fire or other causes before final or partial acceptance of the work.

627.3.2 Placing

- (1) The contractor may perform the work as specified in one of the following ways: Method A, Method B, or Method C, or a combination of the 3, unless a specific method is specified in the contract.

627.3.2.1 Method A, Netting

- (1) Uniformly spread the mulching material over the designated areas to a loose depth of 1/2 to 1 1/2 inches (13 to 38 mm). Use a specific rate of application; dependent on the character of the material, that results in a cover conforming to the requirements specified above in [627.3.1](#). Loosen or make fluffy the mulch material from compacted bales before spreading in place. Unless directed otherwise, begin mulching at the top of the slopes and proceed downward.
- (2) Securely anchor straw or hay mulch by using engineer-approved netting anchored to the ground with pegs or staples to prevent it from floating as the vegetation grows. Instead of this anchorage, the contractor may secure mulch by heavy biodegradable twine fastened by pegs or staples to form a grid with 6 to 10 feet (1.8 to 3 m) spacing.
- (3) The contractor may use department-approved erosion control mats, listed in the PAL, instead of separately applying mulch and netting.

627.3.2.2 Method B, Tackifier

- (1) Treat straw or hay with a tackifier, blow from a machine, and uniformly deposit over designated areas in one operation. Place straw or hay uniformly over the area 1/2 to 1 inch (13 to 25 mm) deep, using 1/2 to 3 tons (3.4 to 6.7 Mg) of mulch per acre. Mix and place tackifier according to the PAL. Within the above limits, the engineer will determine, on the job, the application rate of the mulch and the tackifier, and the engineer may vary the rates during mulching to produce the desired results. Use an engineer-approved machine to place the mulch that blows or ejects by constant air stream a controlled amount of mulch and applies a spray of tackifier to partially coat the straw or hay, sufficient to hold together and keep in place the deposited straw or hay. The contractor may apply the tackifier as an overspray in a separate operation after placing the straw or hay.
- (2) Apply wood fiber, wood chips, or similar material with engineer-approved blowing machines, or other engineer-approved methods, that place a controlled amount of mulch uniformly over the area 1/2 to 1 1/2 inches (13 to 38 mm) deep. Treat areas receiving wood chip mulch, with one pound (0.5 kg) of available nitrogen per 1000 square feet (100 m²) before or after applying the chips.

- (3) Throughout the process, feed the mulch material into the blowing machine to produce a constant and uniform ejection from the discharge spout, and operate in a position to produce mulch of uniform depth and coverage.

627.3.2.3 Method C, Crimping

- (1) Spread the straw or hay mulch uniformly over the designated areas to a loose depth of 1/2 to 1 1/2 inches (13 to 38 mm), using 1 1/2 to 3 tons (3.4 to 6.7 Mg) of mulch per acre, by blowing from a machine, as specified in Method B, or by other engineer-approved methods.
- (2) Immediately after spreading, anchor the mulch in the soil by using a mulch crimper consisting of a series of dull, flat discs with notched edges. Space the 20 inch (500 mm) diameter discs at about 8 inch (200 mm) centers. Equip the crimper with a ballast compartment to permit adjusting the weight for depth control.
- (3) Impress the mulch into the soil 1 1/2 to 2 1/2 inches (38 to 64 mm) deep in one pass of the crimper. The department will not allow mulch crimpers to operate on slopes so steep that damage to the mulch, seedbed, or soil occurs. Anchor the mulch on these areas by one of the following methods: Method A or Method B. Equip and operate tractors to minimize disturbing or displacing the soil. This process may require more than one pass of the crimper to ensure adequate anchoring of the mulch.
- (4) The contractor shall not use Method C if it cannot impress the mulch to a minimum of 1 1/2 inch (38 mm).

627.4 Measurement

- (1) The department will measure Mulching acceptably completed by the square yard or by the ton, whichever the contract specifies.
- (2) If measured by the square yard, the measured quantity equals the number of square yards of surface area that the contractor applied the mulch.
- (3) If measured by the ton, the measured quantity equals the number of tons of mulch provided, placed, and acceptably completed.
- (4) Tackifiers or nitrogen used for treating mulch are incidental to the cost of the work.

627.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
627.0200	Mulching	SY
627.0205	Mulching	TON

- (2) Payment for Mulching is full compensation for providing all materials, including tackifiers or nitrogen; for all hauling, treating, placing, spreading and anchoring of the mulch material; and for maintaining the work and repairing all damaged areas.
- (3) If the contractor opts to use department-approved erosion control mats instead of separately applying mulch and netting, the department will pay for it at the contract unit price for Mulching only.

SECTION 628 EROSION CONTROL

628.1 Description

- (1) This section describes furnishing and installing, or constructing erosion control mats, bale checks or dikes, fences, screens, blankets, and other erosion control devices.
- (2) This section also describes cleaning sediment basins and mobilizations for erosion control.

628.2 Materials

628.2.1 General

628.2.1.1 Acronyms

- (1) Interpret acronyms used throughout this section as follows:

PAL The department's erosion control product acceptability list. The contractor may obtain a copy of the PAL and the prequalification procedure for products not on the PAL from the department.

ECRM Class I, II, and IIIA erosion control revegetative mats.

TRM Class III B, C, and D turf reinforcement mats.

628.2.1.2 Product Acceptability

- (1) The department prequalifies selected erosion control products in the PAL. If the contract specifies, furnish products of the class, type, and subject to the seasonal limitations the PAL designates. Before installing a PAL product, submit to the engineer a written copy of the manufacturer's specifications for installing that product on slopes, channels, shorelines, high wind locations, and next to live traffic lanes as applicable to the contract installation. Install PAL products conforming to those manufacturer's specifications. The department may specify modifications to the manufacturer's procedures for individual materials here within section 628.
- (2) The department may sample and test products supplied in the field to verify that they conform to the PAL prequalification requirements. Provide samples as the engineer directs.

628.2.2 Erosion Mat

- (1) The department must prequalify all erosion mat products before use. Furnish erosion mat products from the PAL
- (2) The PAL identifies prequalified erosion mat products by class and type. Use the required class and type of erosion mat the plans show or the engineer specifies. The contractor may furnish any prequalified erosion mat product of the class and type the plans show or that the engineer specifies.
- (3) If using jute fabric for an erosion mat, use a woven fabric of a uniform open weave of single jute yarn. Use a jute yarn of loosely twisted construction with an average twist of not less than 1 1/2 turns per one inch (25 mm). Ensure the average size of the warp and weft yarns are approximately the same. Furnish the woven fabric in rolled strips. Submit a certificate of compliance certifying that the jute fabric erosion mat conforms to the following:
 - Is a minimum 48 inches (1220 mm) wide with a tolerance of minus one inch (25 mm).
 - Has 78 warp ends, +/- one for each 48 inches (1220 mm) of width. Has 45 weft yarns, +/- 2, per linear yard (m) of length.
 - Weighs 92 pounds per 100 square yards (50 kg/100 m²) +/- 10 percent, measured under average atmospheric conditions.
 - Is non-toxic to vegetation.

628.2.3 Staples

- (1) Furnish U-shaped staples, made of No. 11 (3.05 mm) or larger diameter steel wire, or other engineer-approved material, are one to 2 inches (25 to 50 mm) wide, and not less than 6 inches (150 mm) long for firm soils and not less than 12 inches (300 mm) for loose soils.

628.2.4 Bales

- (1) For bales, use straw, hay, or other engineer-approved material, in good condition, of the dimensions the plans show.

628.2.5 Stakes

- (1) Furnish wood or metal stakes of the dimensions the plans show.

628.2.6 Silt Fence

628.2.6.1 Geotextile Fabric

- (1) Furnish one of the following geotextile fabrics: woven or non-woven polyester, polypropylene, stabilized nylon, polyethylene, or polyvinylidene chloride. For non-woven fabric the contractor may use needle punched, heat bonded, resin bonded, or combinations of all 3. Submit a certificate of compliance certifying that the geotextile conforms to the following:

TEST REQUIREMENT	METHOD	VALUE ^[1]
Minimum grab tensile strength (machine direction)	ASTM D 4632	120 lb (550 N)
Minimum grab tensile strength (cross machine direction)	ASTM D 4632	100 lb (450 N)
Maximum apparent opening size (equivalent standard sieve)	ASTM D 4751	No. 30 (600 µm)
Minimum Permittivity	ASTM D 4491	0.05 s ⁻¹
Minimum ultraviolet stability (strength retained at 500 hrs of exposure)	ASTM D 4355	70 %

^[1] All numerical values represent minimum or maximum average roll values. Average test results from all rolls in a lot must conform the tabulated values.

628.2.6.2 Fence Support System

- (1) Conform to plan requirements.

628.2.7 Silt Screen

- (1) Furnish fabric and submit a certificate of compliance certifying that the fabric conforms to the following:
Thickness 15 mils (0.38 mm)
Minimum grab tensile strength..... 120 lb (530 N)
Minimum equivalent opening No.170 sieve (90 µm)
- (2) Heat seal or sew all fabric seams.
- (3) For flotation, use an 8-inch (200 mm) diameter solid expanded polystyrene log, or engineer-approved equal, with a buoyancy of approximately 20 pounds per foot (9 kg/300 mm). Do not use polystyrene beads or chips.
- (4) For the main load line, use 5/16 inch (8 mm) cable. For ballast, use a 1/4 inch (6 mm) chain.

628.2.8 Sand Bags

- (1) Furnish bags made of canvas, burlap, nylon, or other engineer-approved material filled with concrete sand or other engineer-approved granular material.

628.2.9 Polyethylene Sheeting

- (1) Furnish 6 mil (0.152 mm) or thicker polyethylene sheeting conforming to ASTM D 4397.

628.2.10 Turbidity Barriers

- (1) Furnish barrier made of coated impervious fabric capable of containing all sediment at the location placed. It shall have a cable, with a 5/16 inch (8 mm) or larger diameter, capable of supporting the barrier at the required height above the water. It shall have a self-contained ballast that weighs at least 0.7 pound per foot (1 kg/m). The ballast may be either chain or flexible cable. Barrier ends shall have grommets to lace together adjoining sections. For anchor posts use one of the following: steel fence posts, steel pipes, or steel channels.

- (2) Submit a certificate of compliance certifying that the turbidity barrier fabric conforms to the following:

TEST REQUIREMENT	METHOD	VALUE ^[1]
Minimum grab tensile strength	ASTM D 4632	200 lb (890 N)
Minimum puncture strength	ASTM D 4833	90 lb (400 N)
Maximum permeability	ASTM D 4491	1x10 ⁻⁷ cm/s
Minimum ultraviolet stability	ASTM D 4355	70 %

(strength retained at 500 hrs of exposure)

^[1] All numerical values represent minimum or maximum average roll values. Average test results from all rolls in a lot must conform the tabulated values.

628.2.11 Soil Stabilizer

- (1) Soil stabilizer type A is one of the following: a cementitious soil binder added to wood cellulose fiber mulch, or a bonded fiber matrix. Soil stabilizer type B is a polyacrylimide.
- (2) Furnish soil stabilizer products from the PAL.

628.2.12 Inlet Protection

- (1) Use a type FF geotextile fabric conforming to [645.2.1](#) except use a woven polypropylene fabric. Furnish type FF geotextile fabrics, or bags manufactured from type FF geotextile fabrics, from the PAL.

628.3 Construction

628.3.1 General

- (1) Deliver 25 percent of the plan quantity of erosion mat, erosion bales, silt fence, or manufactured alternative materials for temporary ditch checks, to the project site before construction begins unless the engineer directs otherwise. Deliver the balance required, based on actual site conditions, and determined by consulting with the engineer, in time to install each material as the contract specifies.
- (2) Ensure that erosion control products selected from the PAL are properly installed and maintained to remain in place and functioning as the contract specifies.

628.3.2 Erosion Mat

- (1) Furnish and install protective covering mats or soil retention mats for erosion control on prepared planting areas of slopes, ditches, channels, or shorelines, at locations the plans show or the engineer directs. Conform to the seasonal limitations designated in the PAL for photodegradable products.
- (2) Install as the manufacturer specifies except as follows:
1. Do not use single roll material less than 6 feet (1.8 m) wide in channels.
 2. Entrench mats approximately 3 inches (75 mm) deep along the edge facing traffic for all installations within 5 feet (1.52 m) of active traffic lanes.
 3. Overlap mats by 3 inches (75 mm) or less and anchor with anchoring devices selected from the PAL for all mats the PAL designates as urban.
- (3) Cover TRM's immediately after installation with materials from the PAL as follows:
1. On slopes use either an ECRM or a type A soil stabilizer. If using a soil stabilizer, apply at the manufacturer's recommended rate unless the contract or engineer specifies otherwise.
 2. In channels use an ECRM of a class and type the PAL allows for channel applications.
- (4) Remove all stones, clods, roots, sticks, or other foreign material that prevent the mat from bearing completely on the surface before placing the mat.
- (5) Reseed any seeded areas damaged or destroyed during placement of the erosion mat as specified for the original seeding.
- (6) Dispose of all surplus excavation or materials, and all stones, clods, or other foreign material removed in preparing for placing the mat.
- (7) Apply water uniformly after placing the mat over a seeded area to sufficiently moisten the seedbed to a depth of 2 inches (50 mm) and in a manner that precludes washing or erosion.
- (8) Maintain the erosion mat and repair any damaged areas until the work is accepted.
- (9) The contractor shall not overlap type urban erosion mat with type urban or other type erosion mat.

628.3.3 Erosion Bales

- (1) Furnish bales of straw, hay, or other suitable baled material to form erosion control structures other than ditch checks. Install at locations the plans show or as the engineer directs.
- (2) Maintain the bales as required including removing and disposing of sediment deposits. Remove erosion bales after slopes and ditches are stable and turf develops enough to make future erosion unlikely. The engineer will determine when the contractor meets these criteria satisfactorily. The contractor may use bales as mulch. Dispose of bales not used as mulch in a manner acceptable to the engineer. Reshape ditches; fill sumps and trenches; dispose of excess eroded material; and topsoil, fertilize, and seed the affected area.

628.3.4 Silt Fence

628.3.4.1 Installation and Removal

- (1) Erect the silt fence before starting a construction operation that might cause sedimentation or siltation at the site of the proposed silt fence.
- (2) If possible, construct the silt fence in an arc or horseshoe shape with its ends pointing up slope. Construct the silt fence to the dimensions, and according to the details the plans show. Remove silt fences, as the engineer determines, after stabilizing the slopes and ditches and developing the turf to the extent that future erosion is unlikely. Clean up and restore the surface after removal. The contractor owns all materials remaining after removal and is responsible for their disposal off the right-of-way.

628.3.4.2 Inspection and Maintenance

- (1) Inspect all silt fences immediately after each rainfall and at least daily during prolonged rainfall. Correct any deficiencies immediately. Additionally, review the locations for silt fences and filter barriers in areas that construction activity changed the earth contour and drainage runoff on a daily basis to ensure that the silt fences are properly and effectively located. If deficiencies exist, install additional silt fences as the engineer directs or approves.
- (2) Remove sediment deposits when the build-up exceeds approximately 1/2 the volume capacity of the silt fence. The engineer may order the contractor to remove deposits if the engineer determines that deposits exceed 1/2 the volume capacity of the silt fence. The contractor shall dress, to the existing grade, sediment deposits remaining in place after the silt fence is no longer required, this includes topsoiling, fertilizing, and seeding the affected area.

628.3.5 Silt Screen

- (1) Install the silt screen to prevent drift shoreward or downstream. Securely attach the flotation log to the fabric in both the horizontal and vertical direction.
- (2) Attach the 5/16 inch (8 mm) cable at the flotation members and extend along the entire length of each section of silt screen. Seal a 1/4 inch (6 mm) chain in the lower hem for ballast.
- (3) Use connectors to join the main load line and ballast chain to carry all tensile pressure. Join the fabric for its entire height with grommets and lacing rope.
- (4) Ensure the silt screen extends from the water surface to a maximum 10 foot (3 m) depth.
- (5) Install anchorages or stakes on both shore and stream side to maintain stability. Use a post with deadman or engineer-approved equal for shore anchors. Ensure stream anchors are of sufficient size, type, and strength to stabilize the barrier beyond the construction area.
- (6) Buoy anchors to prevent pulling the barrier under water. Use Danforth-type anchors in sandy bottom and heavy kedge type or mushroom anchors on mud bottoms.
- (7) Maintain the barrier throughout construction operations.
- (8) After completing the work, remove the barrier in a manner that prevents siltation of the river.

628.3.6 Cleaning Sediment Basins

- (1) Clean sediment basins when the engineer determines the sediment has accumulated to an extent that impairs the effectiveness of the sediment basin.
- (2) Dispose of the surplus material according to [205.3.12](#) for disposal of surplus or unsuitable material.

628.3.7 Mobilizations for Erosion Control

- (1) Move personnel, equipment, and materials to the project site for constructing erosion control items at the stages the contract indicates or the engineer directs.
- (2) Submit for approval an ECIP required in [107.20](#) for accomplishing temporary and permanent erosion control work. Stage the ECIP erosion control work to conform to the number of Mobilizations Erosion Control bid items the contract plans show. The department will not allow any deviation from approved staging without the engineer's written approval. The engineer will direct each of the mobilizations. Mobilize with sufficient personnel, equipment, supplies, and incidentals, within 72 hours of the engineer's written order.

628.3.8 Mobilizations Emergency Erosion Control

- (1) Move personnel, equipment, and materials to the project site to install temporary erosion control items on an emergency basis as the engineer directs.
- (2) Mobilize with sufficient personnel, equipment, materials, and incidentals on the job site within 8 hours the engineer's written order to install temporary erosion control items on an emergency basis.
- (3) An emergency is a sudden occurrence of a serious and urgent nature, beyond normal maintenance of erosion control items and mobilizations the ECIP includes. Under this definition, an emergency mobilization requires immediate action to move necessary personnel, equipment, and materials to the emergency site followed by immediate installation of temporary erosion control measures.
- (4) Unless the engineer directs otherwise, replenish stockpiled material delivered as specified for plan quantities in [628.3.1](#) and subsequently used for emergency erosion control to the pre-emergency totals of these stockpiles.

628.3.9 Polyethylene Sheeting

- (1) Install polyethylene sheeting at locations the plans show or as the engineer directs.
- (2) Secure the sheeting from wind and water dislocation. Before placing, remove stones, roots, sticks, and other materials that interfere with the sheeting bearing completely on the soil. Overlap adjacent sheets a minimum of 3 feet (1 m) in the direction of flow; and seal the edges with waterproof tape or other engineer-approved method. Patch damaged areas with sheeting overlapped a minimum of 3 feet (1 m) and seal the joints with waterproof tape or other engineer-approved method. Maintain the sheeting and make satisfactory repairs of damaged areas.
- (3) Upon completing the work, remove the polyethylene sheeting. The contractor shall assume ownership of all removed material.

628.3.10 Turbidity Barriers

- (1) Install turbidity barriers at locations the plans show or as the engineer directs.
- (2) Place all barriers, before beginning adjacent construction, in a manner that causes minimum disturbance of the streambed and banks. Extend the barrier into the stream banks far enough to preclude washing out or erosion around the ends. Drive posts securely into the streambed at 10 foot (3 m) intervals along the line of the barrier installation. Fasten the barrier to the posts and securely anchor the barrier load lines at the barrier ends and at 10 foot (3 m) intervals between the barrier ends, unless the engineer directs otherwise. Provide additional anchoring if necessary to maintain the barrier location during construction operations. Install sand bags as the plans show to anchor the barrier to the streambed. The engineer may require additional sand bags to ensure adequate performance. The contractor, as required by permit under [107.19](#), shall provide and anchor both danger buoys and navigational markers.
- (3) Maintain the integrity of the barrier as necessary to contain erosion from adjacent construction operations. Promptly correct all deficiencies. Barrier maintenance includes removing and disposing of accumulations of soil and other detrimental material.
- (4) Remove the barrier after completing the adjacent work. Delay removal until removing and disposing of accumulated soils and other suspended materials, and all suspended materials settle. Minimize disturbing the streambed and banks during removal operations.
- (5) If the engineer approves, the contractor may substitute sheet pile installed as a part of their construction operation for all or part of the turbidity barrier the plans show.

628.3.11 (Vacant)

628.3.12 Soil Stabilizer

628.3.12.1 General

- (1) Provide soil stabilizer as a soil bonding agent to prevent or minimize erosion. Install on exposed soil surfaces of temporary or permanent slopes as the plans show or as the engineer directs.

628.3.12.2 Soil Stabilizer Type A

- (1) Apply soil stabilizer with conventional hydraulic seeding equipment. Ensure that surrounding surfaces, structures, signs, trees, and shrubs are not over-sprayed. The engineer will not accept the work until the contractor satisfactorily cleans over-sprayed surfaces. Provide a finished application 3/16 inch (4 mm) to 1/4 inch (6 mm) thick.
- (2) For permanent slope applications, sow seed separately, before applying the soil stabilizer, to ensure that the seed has direct contact with the soil.

628.3.12.3 Soil Stabilizer Type B

- (1) Apply soil stabilizer with conventional hydraulic seeding equipment or by dry spreading. Apply the material at the manufacturer's recommended rate unless the engineer directs otherwise.
- (2) For permanent slope applications, apply a department-approved mulch when applying the soil stabilizer or after applying it to protect the seed.

628.3.13 Inlet Protection

- (1) Furnish, install, maintain, and remove type FF geotextile fabric, and fabric hold down and support systems for inlet protection where the plans show or the engineer directs. The contractor may provide manufactured alternatives selected from the PAL.
- (2) For type A inlet protection, install around field inlets until establishing permanent soil stabilization; and around pavement inlets before placing curb, gutter, or curb & gutter.
- (3) For type B inlet protection, install on curb, gutter, curb & gutter, and pavement inlets after placing the surrounding pavement surfaces.
- (4) For type C inlet protection use a wooden 2 x 4 (50 x 100 mm), wrapped and secured in type FF geotextile fabric, installed in front of the curb head as the plans show. The wood shall not block the entire opening of the curb box.
- (5) For type D inlet protection, the contractor may make the bag from type FF geotextile fabric or choose a manufactured type FF bag from the PAL. Ensure that the device is designed to fit the size and shape of the inlet. At a minimum, inspect and maintain after every precipitation event.

628.3.14 Temporary Ditch Checks

- (1) Provide suitable ditch check materials, installed and maintained at locations the plans show or as the engineer directs.
- (2) Construct temporary ditch checks using a double row of erosion bales or a manufactured alternative from the PAL. Place temporary ditch checks across ditches at locations the plans show or as the engineer directs immediately after shaping the ditches or slopes. Excavate upstream sumps as the engineer directs.
- (3) Remove sediment deposits when the build-up exceeds approximately 1/2 the erosion bale structures volume capacity. The engineer may order the contractor to remove deposits if the engineer determines that sediment deposits exceed 1/2 the erosion bale structures volume capacity. Dispose of excess sediment as the engineer directs.
- (4) Remove ditch checks after the slopes and ditches are stable and the turf develops enough to make future erosion unlikely. The engineer will determine when the contractor meets these criteria. The contractor may use bales as mulch. Dispose of bales not used as mulch in a manner acceptable to the engineer. Reshape the ditch; fill sumps and trenches; dispose of excess eroded material; and topsoil, fertilize, and seed the affected area.

628.3.15 Culvert Pipe Ditch Checks

- (1) Install sand bag ditch checks the plans show or as the engineer directs immediately after installing new culverts. Place sand bags on the inlet end of the culvert only. Maintain the sand bags in place until slopes and ditches are stable and turf develops enough to make future erosion unlikely. Remove and dispose of the used sand bags. Remove accumulated sediment or spread it to form a surface suitable for seeding.

628.4 Measurement

628.4.1 General

628.4.1.1 Borrow Sites and Material Disposal Sites

- (1) The department will measure work acceptably completed under selected bid items placed on borrow sites and material disposal sites if the engineer requests that work and that work is consistent with the ECIP. The department will measure only the following bid items using the methods described in their respective measurement subsections:

Mulching	Silt Fence Maintenance
Erosion Mat Delivered	Erosion Mat Installed
Erosion Bales Delivered	Erosion Bales Installed
Temporary Ditch Checks Delivered	Temporary Ditch Checks Installed
Silt Fence Delivered	Silt Fence Installed
Fertilizer Type A	Fertilizer Type B
Seeding	Seeding Temporary

628.4.1.2 Sand Bags

- (1) The department will not measure sand bags. Sand bags are incidental to the bid items that use sand bags.

628.4.2 Erosion Mat Delivered

- (1) The department will measure the Erosion Mat Delivered bid items by the square yard acceptably completed, determined as the same quantity measured for the Erosion Mat Installed bid items under [628.4.3](#).

628.4.3 Erosion Mat Installed

- (1) The department will measure the Erosion Mat Installed bid items by the square yard acceptably completed. The department will not make allowance for portions of the mat that must be entrenched in the soil for any end or junction slot, or for required overlaps.

628.4.4 Erosion Bales Delivered

- (1) The department will measure Erosion Bales Delivered as each individual bale acceptably completed, determined as the same quantity measured for the Erosion Bales Installed bid item under [628.4.5](#).

628.4.5 Erosion Bales Installed

- (1) The department will measure Erosion Bales Installed as each individual bale acceptably completed.

628.4.6 Silt Fence Delivered

- (1) The department will measure Silt Fence Delivered by the linear foot acceptably completed, determined as the same quantity measured for the Silt Fence Installed bid item under [628.4.7](#).

628.4.7 Silt Fence Installed

- (1) The department will measure Silt Fence Installed by the linear foot acceptably completed. The department will measure along the base of the fence, center-to-center of end post, for each section of fence.

628.4.8 Silt Fence Maintenance

- (1) The department will measure Silt Fence Maintenance by the linear foot acceptably completed. The department will measure along the base of the fence, end-to-end of the section maintained, for each time a section of fence is cleaned and repaired.

628.4.9 Silt Screen

- (1) The department will measure Silt Screen by the linear foot acceptably completed.

628.4.10 Cleaning Sediment Basins

- (1) The department will measure Cleaning Sediment Basins by the cubic yard acceptably completed, measured in the vehicle.

628.4.11 Mobilizations Erosion Control

- (1) The department will measure Mobilizations Erosion Control by each individual mobilization acceptably completed. The department will not include the following:
 - 1. Delivering materials provided for in specific delivered bid items in the contract.
 - 2. Work specified under the Mobilizations Emergency Erosion Control bid item, or the work and operations necessary for normal contractor maintenance of erosion control items.
 - 3. The movement of personnel, equipment, and materials to the work site to accomplish installing additional erosion control items the engineer deems necessary to control erosion between the stages contained in the department-approved plan of operations, unless the engineer directs otherwise in writing.

628.4.12 Mobilizations Emergency Erosion Control

- (1) The department will measure Mobilizations Emergency Erosion Control by each individual mobilization acceptably completed. The department will not include delivering temporary erosion control materials provided for in specific delivered bid items in the contract.

628.4.13 Polyethylene Sheeting

- (1) The department will measure Polyethylene Sheeting by the square yard acceptably completed.

628.4.14 Turbidity Barriers

- (1) The department will measure Turbidity Barrier by the square yard acceptably completed. The department will make no allowance for portions of the turbidity barrier considered as part of the anchorages, required overlaps, or having a bottom flap greater than 48 inches (1200 mm).
- (2) If the contractor substitutes sheet pile for turbidity barrier as allowed in [628.3.10](#), the department will measure that turbidity barrier as the plan quantity in square yards of material replaced.

628.4.15 Soil Stabilizer

- (1) The department will measure the Soil Stabilizer bid items by the acre acceptably completed within the limits the contract designates or as the engineer directs.

628.4.16 Inlet Protection

- (1) The department will measure the Inlet Protection bid items as each individual location and type acceptably completed.

628.4.17 Temporary Ditch Checks Delivered

- (1) The department will measure Temporary Ditch Checks Delivered by the linear foot acceptably completed, determined as the same quantity measured for the Temporary Ditch Checks Installed bid item under [628.4.18](#).

628.4.18 Temporary Ditch Checks Installed

- (1) The department will measure Temporary Ditch Checks Installed by the linear foot acceptably completed. If using erosion bales, the department will only measure the length across the ditch, not the length of each row of bales. The department will not measure ditch checks constructed with a single row of bales.

628.4.19 Culvert Pipe Ditch Checks

- (1) The department will measure Culvert Pipe Ditch Checks as each individual location acceptably completed.

628.5 Payment

628.5.1 General

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
628.1105	Erosion Bales Delivered	EACH
628.1110	Erosion Bales Installed	EACH
628.1505	Silt Fence Delivered	LF
628.1510	Silt Fence Installed	LF
628.1520	Silt Fence Maintenance	LF
628.1550	Silt Screen	LF
628.1905	Mobilizations Erosion Control	EACH
628.1910	Mobilizations Emergency Erosion Control	EACH
628.1920	Cleaning Sediment Basins	CY
628.2000 - 2099	Erosion Mat Delivered (class) (type)	SY
628.3000 - 3099	Erosion Mat Installed (class) (type)	SY
628.5505	Polyethylene Sheeting	SY
628.6005	Turbidity Barriers	SY
628.6500 - 6599	Soil Stabilizer (type)	ACRE
628.7000 - 7099	Inlet Protection (type)	EACH
628.7505	Temporary Ditch Checks Delivered	LF
628.7510	Temporary Ditch Checks Installed	LF
628.7550	Culvert Pipe Ditch Checks	EACH

- (2) The department will pay for measured quantities at the contract unit price under selected bid items placed on borrow sites and material disposal sites if the engineer requests that work and that work is consistent with the ECIP. The department will pay for only the following bid items using the methods described in their respective payment subsections:

Mulching	Silt Fence Maintenance
Erosion Mat Delivered	Erosion Mat Installed
Erosion Bales Delivered	Erosion Bales Installed
Temporary Ditch Checks Delivered	Temporary Ditch Checks Installed
Silt Fence Delivered	Silt Fence Installed
Fertilizer Type A	Fertilizer Type B
Seeding	Seeding Temporary

628.5.2 Erosion Mat Delivered

- (1) Payment for the Erosion Mat Delivered bid items is full compensation for providing and delivering acceptable erosion mat materials for the work including staples; and for protecting and storing on the project.

628.5.3 Erosion Mat Installed

- (1) Payment for the Erosion Mat Installed bid items is full compensation for placing and anchoring the mat, including staples; for preparing the seeded areas; for installing end and junction slots; for repairing and reseeding damaged areas; for providing and applying water; and for disposing of all surplus and waste materials.
- (2) The department will pay separately for covering class III types B, C, and D mats with an ECRM under the applicable Erosion Mat bid item, or with type A soil stabilizer under the Soil Stabilizer Type A bid item.

628.5.4 Erosion Bales Delivered

- (1) Payment for Erosion Bales Delivered is full compensation for providing and delivering erosion bales for the work, including stakes; and for protecting and storing on the project.

628.5.5 Erosion Bales Installed

- (1) Payment for Erosion Bales Installed is full compensation for placing all materials, including stakes; for anchoring the bales; for all excavating, including trenches and sumps; for removing excess sediment during construction; for removing and disposing of the bales and all waste or surplus materials, including eroded materials; and for shaping and restoring ditches.

- (2) The department will pay separately for any required topsoiling, fertilizing, or seeding under the applicable bid item.

628.5.6 Silt Fence Delivered

- (1) Payment for Silt Fence Delivered is full compensation for furnishing and delivering silt fence for the work, including all miscellaneous materials; and for protecting and storing on the project.

628.5.7 Silt Fence Installed

- (1) Payment for Silt Fence Installed is full compensation for erecting fence, including all excavating, placing posts, backfilling, and attaching geotextile fabric; and for removing the fence at project completion.

628.5.8 Silt Fence Maintenance

- (1) Payment for Silt Fence Maintenance is full compensation for all required cleaning and repairing; for removing or spreading the accumulated sediment to form a surface suitable for seeding; and for replacing silt fence and all damages caused by overloading sediment material or ponding water adjacent to the silt fence.

628.5.9 Silt Screen

- (1) Payment for Silt Screen is full compensation for providing, assembling, erecting, maintaining, and removing the silt screen barrier.

628.5.10 Cleaning Sediment Basins

- (1) Payment for Cleaning Sediment Basins is full compensation for all excavating; and for disposing of surplus material.

628.5.11 Mobilizations Erosion Control

- (1) Payment for Mobilizations Erosion Control is full compensation for the staged moving of personnel, moving equipment, and moving materials. The department will pay separately for delivery and installation of erosion control devices under the other bid items in this section.
- (2) Failure to mobilize within 72 hours of the engineer's written order will result in a \$300 per calendar day deduction from money due under the contract, for each calendar day of delay. The engineer may extend the 72-hour period for delays that are not the contractor's fault.

628.5.12 Mobilizations Emergency Erosion Control

- (1) Payment for Mobilizations Emergency Erosion Control is full compensation for the staged moving of personnel, moving equipment, and moving materials. The department will pay separately for delivery and installation of temporary erosion control devices under the other bid items in this section.
- (2) Failure to mobilize within 8 hours, will result in a \$300 per calendar day deduction from money due under the contract, for each calendar day of delay. The engineer may extend the 8-hour period for delays that are not the contractor's fault.

628.5.13 Polyethylene Sheeting

- (1) Payment for Polyethylene Sheeting is full compensation for furnishing and delivering the polyethylene sheeting to the project site; for storing on the project; for installing the sheeting; for all excavating and backfilling; for securing the sheeting and sealing the edges of the sheeting; and for removing and disposing of the sheeting and surplus materials.

628.5.14 Turbidity Barriers

- (1) Payment for Turbidity Barriers is full compensation for furnishing, assembling, installing, maintaining, and removing the turbidity barrier; and for sandbags, buoys, navigational markers, anchors, and anchor ropes.
- (2) If the contractor substitutes sheet pile for turbidity barrier as allowed in [628.3.10](#), the department will pay for the plan quantity of turbidity barrier replaced.

628.5.15 Soil Stabilizer

- (1) Payment for the Soil Stabilizer bid items is full compensation for furnishing, mixing, and applying soil stabilizer.

628.5.16 Inlet Protection

- (1) Payment for the Inlet Protection bid items is full compensation for furnishing, transporting, and installing all materials; and for maintaining and removing the inlet protection devices.

628.5.17 Temporary Ditch Checks Delivered

- (1) Payment for Temporary Ditch Checks Delivered is full compensation for furnishing and delivering the ditch check material, including stakes, to the project site; and for protecting and storing on the project.

628.5.18 Temporary Ditch Checks Installed

- (1) Payment for Temporary Ditch Checks Installed is full compensation for installing and removing ditch checks at project completion or as the engineer directs; for repairing and reseeding damaged areas; and for disposing of all surplus and waste material.
- (2) The department will not pay for installing ditch checks if constructed of a single row of erosion bales.

628.5.19 Culvert Pipe Ditch Checks

- (1) Payment for Culvert Pipe Ditch Checks is full compensation for furnishing and installing sand bags; for all excavating; for removing and disposing of sand bags and all waste, surplus, or eroded materials; and for shaping and restoring the area.

SECTION 629 FERTILIZER AND AGRICULTURAL LIMESTONE

629.1 Description

- (1) This section describes furnishing and incorporating fertilizing material in the soil on areas of proposed seeding or proposed sodding.
- (2) This section also describes furnishing and incorporating agricultural limestone in the soil.

629.2 Materials

629.2.1 Fertilizers

629.2.1.1 General

- (1) Use fertilizers for seeding, sodding, or other planting that are standard, commercial, packaged or bulk products, in granular or liquid form conforming to Wisconsin Statutes and the Wisconsin Administrative Code Chapter ATPC 40. Ensure that each container of packaged fertilizer is plainly marked with the analysis of the contents showing minimum percentages of total nitrogen, available phosphoric acid, and soluble potash. If furnishing the fertilizer in bulk, include an invoice in each shipment indicating the minimum percentages of total nitrogen, available phosphoric acid, and soluble potash in the contents.
- (2) If using fertilizer with a total of nitrogen, phosphoric acid, and potash greater than 32 percent for type A or 50 percent for type B, apply them at a rate that provides equal nitrogen, phosphoric acid, and potash.

629.2.1.2 Type A

- (1) Type A fertilizer shall conform to the following minimum requirements:

Nitrogen, not less than	16%
Phosphoric Acid, not less than	6%
Potash, not less than	6%
- (2) The total of nitrogen, phosphoric acid, and potash shall equal at least 32 percent.
- (3) Total nitrogen shall at least equal the sum of the phosphoric acid and soluble potash.

629.2.1.3 Type B

- (1) Type B fertilizer shall conform to the following minimum requirements:

Nitrogen, not less than	16%
Phosphoric Acid, not less than	6%
Potash, not less than	24%
- (2) The total of nitrogen, phosphoric acid, and potash shall equal at least 50 percent.

629.2.2 Agricultural Limestone

- (1) Conform to chapter 94.66 of the Wisconsin Statutes and of the Wisconsin Administrative Code Chapter ATPC 44. Furnish limestone with a neutralizing index of not less than 40 or more than 109.
- (2) Before using, furnish a statement to the engineer indicating the index zone or grade of the limestone for each deposit.

629.3 Construction

629.3.1 Fertilizer

629.3.1.1 General

- (1) Uniformly apply the fertilizer selected for the seeding areas and incorporate into the soil by light discing or harrowing. If applying granular fertilizer, ensure it is well pulverized and free from lumps.
- (2) If incorporating fertilizer into topsoiled areas, the contractor may apply it just before, and in conjunction with, final discing or harrowing, or if hand manipulating the topsoil, apply it just before final raking and leveling.
- (3) If placing fertilizer on surfaces with no topsoil, prepare the soil by discing or harrowing to at least 6 inches (150 mm) deep and then incorporate the fertilizer as specified above.
- (4) If sowing seeding areas by pressure sprayer, then fertilize by placing the required amount of fertilizer in the tank, mixing with the water and the seed, agitating constantly, and apply during the seeding operation. If applying fertilizer this way then the department will not require discing and harrowing after placement.

- (5) If fertilizing areas to receive sod, spread the fertilizer uniformly over the soil before sodding at the rate specified below, and then work the fertilizer into the soil while preparing as specified for preparing the earth bed in [631.3.1](#).
- (6) If applying fertilizer for work specified under section 632, then apply the fertilizer as specified in that section.

629.3.1.2 Type A

- (1) Apply fertilizer containing 32 percent total of nitrogen, phosphoric acid, and potash at 7 pounds per 1000 square feet (3.5 kg/100 m²) of area, unless the contract specifies otherwise. For type A fertilizer that contains a greater percentage of components, determine the application rate by dividing 112 by the greater percentage.

629.3.1.3 Type B

- (1) Apply fertilizer containing 50 percent total of nitrogen, phosphoric acid, and potash at 7 pounds per 1000 square feet (3.5 kg/100 m²) of area, unless the contract specifies otherwise. For type B fertilizer that contains a greater percentage of components determine the application rate by dividing 175 by the greater percentage.

629.3.2 Agricultural Limestone Treatment

- (1) Unless the contract specifies otherwise, spread agricultural limestone over the contract-designated areas at a uniform rate, measured in pounds per 100 square feet (kg/100 m²), as follows:

INDEX ZONES	40-49	50-59	60-69	70-79	80-89	90-99	100-109
RATE	140 (70)	120 (60)	100 (50)	90 (45)	80 (40)	70 (35)	60 (30)

- (2) To conveniently check the required application rate, the contractor may measure materials used on a volumetric basis, providing the conversion from weight to volume is determined from representative samples of materials used.
- (3) Incorporate the agricultural limestone with the required fertilizers into the soils in the designated areas. The pertinent construction requirements applicable to fertilizers shall apply to those materials also.

629.4 Measurement

- (1) The department will measure the Fertilizer bid items by the hundred pounds (CWT) acceptably completed, measured based on an application rate of 7 pounds per 1000 square feet (3.5 kg/100 m²). The department will not measure fertilizer used for the bid items under section 632. The measured quantity equals the number of hundred-weight (CWT) of material determined by multiplying the actual number of cwt. of material incorporated by the ratio of the actual percentage of fertilizer components used to 32 percent for type A and to 50 percent for Type B.
- (2) The department will measure Agricultural Limestone Treatment by the ton acceptably completed, measured based on an application rate of 100 pounds per 1000 square feet (50 kg/100 m²) and an index zone of 60-69. The measured quantity equals the number of tons of material determined by multiplying the actual number of tons of material incorporated by 50 and dividing by the application rate required for the index zone of the material used.

629.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
629.0200 - 0299	Fertilizer (type)	CWT
629.1100	Agricultural Limestone Treatment	TON

- (2) Payment for the Fertilizer bid items is full compensation for providing, hauling, placing, and incorporating in the work.
- (3) Payment for Agricultural Limestone Treatment is full compensation for providing, hauling, placing and incorporating the required materials in the soil.

SECTION 630 SEEDING

630.1 Description

- (1) This section describes preparing seed beds and furnishing and sowing the required seed on slopes, appurtenances, and other areas, and on borrow pits and material disposal sites.
- (2) This section also describes furnishing and sowing temporary seed mixture on the slopes and appurtenances of temporary embankments and roadways.

630.2 Materials

630.2.1 Seed

630.2.1.1 General Requirements

- (1) Conform to the Wisconsin Statutes and Wisconsin Administrative Code Chapter ATCP 20 regarding noxious weed seed content and labeling.
- (2) Use seed within one year of the test date appearing on the label.
- (3) Seed mixtures 70 and 70A contain wild type forbs and grasses. Wild type is defined as seed that is derived directly from native, wild stock, including seed that was wild collected and placed into production or has been harvested directly from native stands.

630.2.1.2 Purity and Germination

- (1) Test seed according to the methods and procedures used for sampling and analyzing seed for purity, germination, and noxious weed seed content specified in the current edition of Rules for Testing Seed, published by the Association of Official Seed Analysts.

630.2.1.3 Inoculation

- (1) Inoculate legume seed (white clover, red clover, ladino clover, alsike clover, alfalfa, empire birdsfoot trefoil, partridge pea, purple prairie clover, Canada tick-trefoil, and lupine) unless it has been pre-inoculated by the vendor. Follow the inoculation instructions that come with the culture purchases. If applying the seed according to method B, [630.3.3.2](#), treat seeds requiring inoculation with 5 times the amount of inoculant recommended in the instructions.
- (2) Avoid exposure of the culture or inoculated seed to the sunlight, and in no case shall any exposure exceed 1/2 hour.

630.2.1.4 Storing Seed

- (1) Store any seed delivered before use in a manner that protects it from damage by heat, moisture, rodents, or other causes. Discard and replace any previously tested and accepted seed that becomes damaged.

630.2.1.5 Seed Mixtures

630.2.1.5.1 Right-of-Way

630.2.1.5.1.1 Permanent

630.2.1.5.1.1.1 Composition

- (1) Seed mixtures for use on the right-of-way and easements shall, unless specified otherwise, be composed of seeds of the purity, germination and proportions, by weight, as given in the Table of Highway Seed Mixtures and the Table of Native Seed Mixtures.
- (2) Use seed of the species and varieties listed below. If no variety is listed, there will be no restriction on the variety furnished, except as follows: Species composed of pure live seed (PLS) shall contain no named or improved varieties. PLS shall be grown in Wisconsin or northern Illinois, northeastern Iowa or eastern Minnesota. PLS for seed mixtures 70 and 70A shall be packaged separately by species and clearly labeled with the vendor's name, species common and botanical names, gross weight, percent PLS, year of harvest and any specialized treatments that have been applied to ensure or enhance germination. If PLS is not listed, determine PLS by multiplying the percent germination times the percent purity. Minimum percent purity for native for species is 90 percent. If a listed species is not available, substitutions may be made with engineer's approval and must be documented.

- (3) Mix native species at the project site. Clean and debeard seeds having awns or excessive hairs before mixing.

SPECIES COMMON NAME	SPECIES BOTANICAL NAME	ACCEPTABLE VARIETIES
Kentucky Bluegrass	<i>Poa pratensis</i>	Low Maintenance
Red Fescue	<i>Festuca rubra</i>	Creeping
Hard Fescue	<i>Festuca ovina</i> <i>var. duriuscula</i>	Improved
Tall Fescue	<i>Festuca arundinacea</i>	Improved turf type
Salt Grass	<i>Puccinella distans</i> <i>Puccinella distans</i>	Fult's Salty
Redtop	<i>Agrostis alba</i>	
Timothy	<i>Phleum pratense</i>	
Canada Wild Rye ^[1]	<i>Elymus canadensis</i>	
Perennial Ryegrass	<i>Lolium perenne</i>	
Perennial Ryegrass	<i>Lolium perenne</i>	Improved Fine
Annual Ryegrass	<i>Lolium multiflorum</i>	
Alsike Clover	<i>Trifolium hybridum</i>	
Red Clover	<i>Trifolium pratense</i>	
White Clover	<i>Trifolium repens</i>	
Birdsfoot Trefoil	<i>Lotus corniculatus</i>	Empire
Japanese Millet	<i>Echinochola crusgalli</i> <i>var. frumentacea</i>	
Annual Oats	<i>Avena sativa</i>	
Alfalfa	<i>Medicago sativa</i>	
Bromegrass	<i>Bromus inermis</i>	
Orchardgrass	<i>Dactylis glomerata</i>	
Ladino Clover	<i>Trifolium repens</i> <i>var. latum</i>	Ladino
Agricultural Rye	<i>Secale cereale</i>	
Winter Wheat	<i>Triticum aestivum</i>	

^[1] Pure live seed

TABLE OF HIGHWAY SEED MIXTURES

SPECIES	PURITY minimum %	GERMINATION minimum %	MIXTURE PROPORTIONS in percent				
			NO. 10	NO. 20	NO. 30	NO. 40	NO. 60
Kentucky Bluegrass	98	85	40	6	10	35	
Red Fescue	97	85	25		30	20	
Hard Fescue	97	85		24	25	20	
Tall Fescue	98	85		40			
Salt Grass	98	85			10		
Redtop	92	85	5				
Timothy	98	90					12
Canada Wild Rye		PLS ^[1]					10
Perennial Ryegrass	97	90	20	30			
Improved Fine Perennial Ryegrass	96	85			15	25	
Annual Ryegrass	97	90					30
Alsike Clover	97	90					4
Red Clover	98	90					4
White Clover	95	90	10				
Birdsfoot Trefoil	95	80			10		
Japanese Millet	97	85					20
Annual Oats	98	90 ^[1]					20

^[1] Substitute winter wheat for annual oats in fall plantings started after September 1.

TABLE OF NATIVE SEED MIXTURES

SPECIES	SPECIES BOTNICAL NAME	PURITY AND GERMINATION minimum %	MIXTURE PROPORTIONS in percent	
			NO. 70	NO. 70A
Canada Anemone	<i>Anemone canadensis</i>	PLS	2	
Butterflyweed	<i>Asclepias tuberosa</i>	PLS		2
New England Aster	<i>Aster novae-angliae</i>	PLS	2	2
Partridge-pea	<i>Chamaecrista (Cassia) fasciculata</i>	PLS		2
Purple Prairie Clover	<i>Dalea (Petalostemum) purpurea</i>	PLS	2	2
Canada Tick-trefoil	<i>Desmodium canadense</i>	PLS	2	
Flowering Spurge	<i>Euphorbia corollata</i>	PLS		2
Wild Geranium	<i>Geranium maculatum</i>	PLS	2	
Western Sunflower	<i>Helianthus occidentalis</i>	PLS	3	2
Rough Blazingstar	<i>Liatris aspera</i>	PLS		2
Prairie Blazingstar	<i>Liatris pycnostachya</i>	PLS	2	
Lupine	<i>Lupinus perennis</i>	PLS		3
Wild Bergamot	<i>Monarda fistulosa</i>	PLS	2	
Horse Mint	<i>Monarda punctata</i>	PLS		2
Yellow Coneflower	<i>Ratibida pinnata</i>	PLS	2	2
Showy Goldenrod	<i>Solidago speciosa</i>	PLS	2	2
Spiderwort	<i>Tradescantia ohiensis</i>	PLS	2	2
Golden Alexanders	<i>Zizia aurea</i>	PLS	2	
Big Bluestem	<i>Andropogon gerardi</i>	PLS	15	15
Sideoats Grama	<i>Bouteloua curtipendula</i>	PLS	15	20
Canada Wildrye	<i>Elymus Canadensis</i>	PLS	15	15
Junegrass	<i>Koeleria macrantha</i>	PLS		5
Little Bluestem	<i>Schizachyrium (Andropogon) scoparium</i>	PLS	15	20
Indiangrass	<i>Sorghastrum nutans</i>	PLS	15	

630.2.1.5.1.1.2 Mixture

- (1) The contractor shall select a seed mixture or mixtures that meet with the engineer's approval, and unless specified otherwise in the contract, shall conform to the following:
1. Use seed mixture No. 10 where average loam, heavy clay, or moist soils predominate.
 2. Use seed mixture No. 20 where light, dry, well-drained, sandy, or gravelly soils predominate and for all high cut and fill slopes generally exceeding 6 to 8 feet (1.8 to 2.4 m), except where using No. 70.
 - 3 Use seed mixture No. 10 or No. 20 on all ditches, inslopes, median areas, and low fills, except where using No. 30 or No. 70.
 4. Use seed mixture No. 30 for medians and on slopes or ditches generally within 15 feet (4.5 m) of the shoulder where a salt-tolerant turf is preferred.
 5. Use seed mixture No. 40 in urban or other areas where a lawn type turf is preferred.
 6. Use seed mixture No. 60 only on areas, the contract designates or the engineer specifies. Use it as a cover seeding for newly graded wet areas or as a nurse crop for specified wetland seed mixtures. The contractor shall not apply it to flooded areas.

7. Use seed mixture Nos. 70 and 70A on slopes and upland areas the contract designates or the engineer specifies. Use seed mixture No. 70 on loamy soils and seed mixture No. 70A on sandy soils.

630.2.1.5.1.2 Temporary

- (1) Under the Seeding Temporary bid item, use a temporary seed mixture conforming to [630.2.1.5.1.4](#). Use oats in spring and summer plantings. Use winter wheat or rye for fall plantings started after September 1.

630.2.1.5.1.3 Nurse Crop

- (1) If seeding bare soil with either mixture 70 or 70A, include the work under the Seeding Nurse Crop bid item.

630.2.1.5.1.4 Borrow Pits and Material Disposal Sites

- (1) For seeding borrow pits and material disposal sites beyond the right-of-way, use seed mixtures conforming to seed mixture No. 10, No. 20, No. 70 or No. 70A of [630.2.1.5.1.1](#) or a borrow pit mixture composed of seeds of the species, purity, germination and proportions, by weight as given below:

PERMANENT		
SPECIES	% MINIMUM PURITY	% MINIMUM GERMINATION
Alfalfa	98	90
Bromegrass	85	85
Orchardgrass	80	85
Timothy	98	90
Red Clover	98	90
Alsike Clover	97	90
Ladino Clover	95	90
Kentucky Bluegrass	98	85
Birdsfoot Trefoil	95	80
TEMPORARY		
SPECIES	% MINIMUM PURITY	% MINIMUM GERMINATION
Annual Oats	98	90
Agricultural Rye	97	85
Winter Wheat	95	90
NURSE CROP		
SPECIES	% MINIMUM PURITY	% MINIMUM GERMINATION
Annual Oats	98	90
Annual Ryegrass	97	90
Winter Wheat	95	90

- (2) For the borrow pit mixture use, by weight, 60 percent temporary species seeds and 40 percent permanent species seeds.
- (3) For the temporary component, use any combination of temporary seeds listed in the table above.
- (4) For the permanent component, use seeds from not more than 4 of the permanent species listed in the table above in any combination.
- (5) When nurse crop is required for spring seeding before June 15, use annual oats. For fall seeding after October 15, use winter wheat, or annual ryegrass.

630.3 Construction

630.3.1 General

- (1) If not protecting with a mulch cover, perform seeding, except Nos. 60, 70 and 70A mixtures at times of the year when temperature and moisture conditions are suitable for seeding, except during midsummer.
- (2) Perform seeding, except Nos. 60, 70 and 70A mixtures, in conjunction with mulching as specified in [section 627](#) at any time the engineer allows.
- (3) The contractor may perform seeding of Nos. 60, 70 and 70A mixtures at any time soil conditions are suitable, except between June 15 and October 15, unless the engineer allows otherwise.

- (4) Perform seeding with the selected seed mixture, sown at the specified rate.

630.3.2 Preparation of Seed Bed

- (1) Complete grading, shouldering, topsoiling, and fertilizing, if part of the work under contract, before permanent seeding, except the contractor may place the fertilizer and seed mixture in one operation if using equipment designed for the purpose.
- (2) Just before seeding, work the area being seeded with discs, harrows, or other appropriate equipment to obtain a reasonably even and loose seedbed. Place topsoil as specified in [625.3.3](#).

630.3.3 Sowing

- (1) Select the method of sowing from either method A, method B, or method C as described below. Obtain the engineer's approval for the selected method.

630.3.3.1 Method A

- (1) Sow the selected seed mixture using equipment adapted to the purpose, or by scattering it uniformly over the areas to be seeded. Lightly rake or drag to cover the seed with approximately 1/4 inch (6 mm) of soil. After seeding, lightly roll or compact the areas using suitable equipment, preferably the cultipacker type, when the engineer judges the seedbed too loose, or if the seedbed contains clods that might reduce seed germination. The contractor shall not roll slopes steeper than 1:3.
- (2) If scattering seed by hand, perform this work with satisfactory hand seeders and only when the air is calm enough to prevent seeds from blowing away.

630.3.3.2 Method B

- (1) Sow or spread the seed upon the prepared bed using a stream or spray of water under pressure and operated from an engineer-approved machine designed for that purpose. Place the selected seed mixture and water into a tank, provided within the machine, in sufficient quantities that when spraying the seed on a given area it is uniformly spread at the required application rate. During this process, keep the tank contents stirred or agitated to provide uniform distribution. Spread the tank contents within one hour after adding the seed to the tank. The engineer will reject seed that remains mixed with the water for longer than one hour. The engineer will not require dragging or rolling.

630.3.3.3 Method C

- (1) For spring seeding of seed mixtures 70 and 70A into existing ground cover, mow existing vegetation to 4 inches or less in height 2 to 4 weeks before seeding. Ten to 14 days after mowing, spray with vegetation control herbicide conforming to [632.2.12](#).
- (2) For fall seeding of seed mixtures 70 and 70A into existing ground cover, mow existing vegetation to 4 inches or less in height 4 to 6 weeks before seeding. Ten to 14 days after mowing, spray with vegetation control herbicide conforming to [632.2.12](#). Retreat with vegetation control herbicide 10 to 14 days after initial application if live vegetation persists.
- (3) Seed with a no-till rangeland type drill. If the configuration of the area to be seeded allows, apply seed at 1/2 the specified seed rate and apply the second 1/2 in a perpendicular direction.

630.3.3.4 Borrow Pits and Material Disposal Sites

- (1) Seed borrow pits, and material disposal sites off the right-of-way, with the selected seed mixture specified in [630.2.1.5.1.4](#). Consult with the landowner or the landowner's agent when selecting the seed mixture.

630.3.3.5 Seeding Rates

630.3.3.5.1 Right-of-Way

- (1) Use the following sowing rate for seeds in pounds (kg) per 1000 square feet (100 m²) of area:
 - Seed mixture No. 10 at 1 1/2 pounds (1.0 kg)
 - Seed mixture No. 20 at 3 pounds (1.5 kg)
 - Seed mixture No. 30 at 2 pounds (1.0 kg)
 - Seed mixture No. 40 at 2 pounds (1.0 kg)
 - Seed mixture No. 60 at 1 1/2 pounds (0.5 kg) (equivalent)^[1]
 - Seed mixture No. 70 or 70A at 0.4 pounds (0.18 kg) (equivalent)^[1]
 - Temporary seeding at 3 pounds (1.5 kg)
 - Nurse crop seeding at 0.8 pounds (0.36 kg)

^[1] Determine the actual seeding rate for seed mixture No. 60 by multiplying the equivalent seeding rate for each of these mixtures by the sum of the unadjusted and adjusted percentages of the various species in the seed mixtures as sown.

- (2) The unadjusted percentage equals the minimum percent of purity and germination specified in the table of seed mixtures contained in [630.2.1.5.1.1.1](#) for the applicable species.
- (3) Obtain the adjusted percentage for each of the PLS species by dividing the specified percentage of the species by the product of the percent of purity and the percent of germination for each of the PLS species as delivered.

630.3.3.5.2 Borrow Pits and Material Disposal Areas

- (1) For seeding borrow pits, and material disposal off the right-of-way, sow the seed mixtures specified in [630.2.1.5.1.4](#) at the following rates per pound (kilogram) per 1000 square feet (100 m²) of area:
 - Seed mixture No. 10 at 3/4 pound (1.0 kg)
 - Seed mixture No. 20 at 1 pound (1.0 kg)
 - Seed mixture No. 30 at 1 1/2 pounds (1.0 kg)
 - Seed mixture No. 70 or 70A at 0.4 pounds (0.18 kg)
 - Borrow pit mixture at 1 1/2 pounds (0.8 kg)

630.3.3.6 Establishment Period for Native Seeding

- (1) During the growing season after planting of seed mixture 70 or 70A, mow all seeded areas twice as directed by the engineer. Mow vegetation back to 6 inches high when it has reached a height of at least 12 inches.
- (2) During the growing season after planting seed mixture 70 or 70A, eradicate the following species from the seeded areas as soon as they become evident:

SPECIES COMMON NAME	SPECIES BOTANICAL NAME
Musk thistle	<i>Carduus nutans</i>
Spotted knapweed	<i>Centaurea maculaosa</i>
Canada thistle	<i>Cirsium arvense</i>
Bull thistle	<i>Cirsium vulgare</i>
Field bindweed	<i>Convolvulus arvensis</i>
Leafy spurge	<i>Euphorbia esula</i>
Sweetclover	<i>Melilotus spp.</i>
Wild parsnip	<i>Pastinaca sativa</i>

- (3) Eradicate by hand pulling or by applying a vegetation control herbicide conforming to [632.2.12](#) to individual plants.

630.4 Measurement

- (1) The department will measure the Seeding bid items by the pound acceptably completed.
- (2) The department will measure quantities based on net weights of seed shipments, or on quantities weighed on department-approved scales the contractor furnishes.
- (3) The department will make deductions for all quantities wasted or not actually incorporated in the work according to the contract.
- (4) The department will determine the equivalent pounds of seed furnished and applied by dividing the actual pounds of seed applied by the sum of the unadjusted and adjusted percentages of the various species in the seed mixture sown.
- (5) The department will use the unadjusted and adjusted percentages determined in [630.3.3.5.1](#).

630.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
630.0100 - 0199	Seeding (mixture)	LB
630.0200	Seeding Temporary	LB
630.0300	Seeding Borrow Pit	LB
630.0400	Seeding Nurse Crop	LB

- (2) Payment for the Seeding bid items is full compensation for providing, handling, and storing all seed; for providing the required culture and inoculating seed as specified; and for preparing the seed bed, sowing, covering and firming the seed. If the landowner does not want the pit or material disposal site seeded, or seeded with any of the mixtures allowed, the department will not make payment for fertilization or seeding of those areas.

SECTION 631 SODDING

631.1 Description

- (1) This section describes furnishing and laying live sod on the shoulders, slopes, ditches, or at other designated locations, and constructing sod ditch checks or similar structures as the plans show, the contract specifies or as the engineer directs.

631.2 Materials

631.2.1 Sod

- (1) The sod shall consist of a dense, well-rooted growth of permanent and desirable grasses, indigenous to the general locality it is to be placed, that is practically free from weeds or undesirable grasses. When cutting the sod, the grass should be approximately 2 inches (50 mm) long. If longer, cut the grass to approximately this length and rake the sod free of debris.
- (2) Cut the sod in uniform commercial size strips.
- (3) Make the sod thickness as uniform as possible, approximately 3/4 inch (19 mm) or more, depending on the nature of the sod, so that practically all of the dense root system is retained, but exposed, in the sod strip and so that handling the sod causes no undue tearing or breaking.
- (4) If the sod is in a dry condition such that cutting it causes crumbling or breaking, the contractor shall, at least 12 hours before cutting, apply water to it in sufficient quantities to provide a well-moistened sod throughout the depth it is cut.
- (5) Sod provided under the Sod Lawn bid item shall have a lush appearance, be dense, have a uniform texture, and be bright in color throughout. The sod shall not contain blade widths of 1/4 inch (6 mm) or greater. Provide a weed free sod that contains no more than 3/8 inch (10 mm) of thatch over the base soil. The sod shall consist of a blend or mix of at least 4 fine-leaved turf grasses. At least 2/3 of the grasses by weight, as determined by initial seeding proportions, consists of improved/elite type Kentucky bluegrass varieties.
- (6) Under the Sod Erosion Control bid item, provide a low maintenance type, dense, and of uniform texture. Provide a sod free of noxious weeds and that contains a combined total of 3 percent or less grassy weeds, sedges, broadleaf weeds, or coarse grasses. The sod shall consist of a blend or mix of at least 4 fine-leaved turf grasses. At least 70 percent of the grasses by weight, as determined by initial seeding proportions, shall consist of acceptable low maintenance varieties or species as listed by the UW Extension. The contractor may obtain this list from the UW Madison, horticulture department, turf grass extension.
- (7) The Sod Erosion Control Sandy Soil bid item shall conform to all requirements for Sod Erosion Control and shall be commercially produced on soil having 10 percent or less organic matter by mass.

631.2.2 Water

- (1) When watering sodded areas, use clean water, free of impurities or substances that might injure the sod.

631.3 Construction

- (1) The contractor shall provide the type of sod the plan designates or the engineer directs consistent with the following criteria:
 1. Under the Sod Lawn bid item, use in areas where the property owner provides all necessary maintenance, including mowing, fertilizing, and watering, and where the primary objective is for aesthetics. Do not use in urban or suburban areas where maintenance is limited to mowing by the property owner or municipality.
 2. Under the Sod Erosion Control bid item, use on limited areas of a project where a quick stand of vegetation is needed for erosion control purposes, or in urban or suburban areas where the primary objective is aesthetics, but where maintenance is limited to mowing.
 3. Under the Sod Erosion Control Sandy Soil bid item, use in the same areas as Sod Erosion Control, but where sandy or gravelly soils predominate.

631.3.1 Preparing the Earth Bed

- (1) Before sodding, construct the proposed area to the required cross section and contour, and round the tops and bottoms of the slopes to a minimum 4-foot (1.2 m) radius curve. Ensure that the sodded areas are free from stones, roots, or other undesirable foreign material. Loosen the soil on the sodded area to at least one inch (25 mm) deep and bring it to a reasonably fine granular texture by equipment or hand methods adapted to the purpose.

631.3.2 Placing the Sod

- (1) Moisten the earth bed that the sod is being placed on to the loosened depth, if not naturally sufficiently moist. Do not place frozen sod, nor place sod on frozen soil. Place the sod on the bed within approximately 24 hours after cutting. Lay the sod so that the joints at abutting ends of sod strips are not continuous. Lay each sod strip to abut snugly against the previously laid strip.
- (2) Lay sod in strips of commercial size where possible. Do not lay partial-size strips of sod smaller than 18 inches (450 mm) by 24 inches (600 mm). When laying the sod, roll it or firmly but lightly tamp with suitable wooden or metal tampers to set or press the sod into the underlying soil.
- (3) At points where water will flow over a sodded area, turn the upper edges of the sod strips into the soil below the adjacent area and place a layer of earth over this juncture. Compact the earth thoroughly so surface water flows over the upper edge of the sod.
- (4) At the limits of sodded areas, if possible, place the end strips to achieve a broken line, and turn the ends of the strips in and treat as described above.

631.3.3 Staking and Cleanup

- (1) On all slopes steeper than one unit vertical to 4 units horizontal (1:4), stake the sod, or peg with pieces of plasterers' lath or equivalent stakes, at least 6 inches (150 mm) long, spaced as the soil nature and slope steepness dictate, from 18 to 36 inches (450 to 900 mm) apart along the length of the sod strip. If possible, place stakes near the top edge of the sod strip and drive plumb through the sod. After installing, stakes should hold the sod firmly in place and present no danger to pedestrians or mowing crews.
- (2) Stake all sod placed in ditches, flumes, or other drainage components, where a concentrated flow of water is expected, regardless of the slope. After completing the surface staking, clear the surface of loose sod, excess soil, or other foreign material.

631.3.4 Fertilizer

- (1) If the contract contains the bid item Fertilizer, then fertilize areas receiving sod according to [629.3.1.1](#) unless otherwise specified.

631.3.5 Watering

- (1) Under the Sod Water bid item, furnish and apply water to sodded areas. After staking and cleanup, moisten the sod thoroughly by sprinkling with water. Keep all sodded areas thoroughly moist by watering or sprinkling if rainfall is not sufficient to achieve sod rooting to the earth bed. Water for 30 days after placement or as the engineer directs. Apply water in a manner to preclude washing or erosion.

631.4 Measurement

- (1) The department will measure Sod Lawn, Sod Erosion Control, and Sod Erosion Control Sandy Soil by the square yard acceptably completed.
- (2) The department will measure Sod Water by volume in gallons acceptably completed. The department will determine volume by engineer-approved meters or from tanks of known capacity.

631.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
631.0300	Sod Water	MGAL
631.1000	Sod Lawn	SY
631.1100	Sod Erosion Control	SY
631.1200	Sod Erosion Control Sandy Soil	SY

- (2) Payment for Sod Lawn, Sod Erosion Control, and Sod Erosion Control Sandy Soil is full compensation for preparing the earth bed; and for furnishing, placing, staking, and rolling the sod. Payment also includes watering if the contract does not contain the Sod Water bid item.
- (3) Payment for Sod Water is full compensation for providing, hauling, and applying the water.

SECTION 632 FURNISHING AND PLANTING PLANT MATERIALS

632.1 Description

- (1) This section describes furnishing and planting plants of the species, varieties and sizes specified, and includes furnishing all necessary materials, excavating plant holes, salvaging topsoil, transplanting, backfilling, pruning, mulching, watering, heeling in, fertilizing, wrapping, guying and bracing, protecting against rodents and applying anti-desiccant, disposing of surplus and waste materials, and necessary care and required replacements pending acceptance.

632.2 Materials

632.2.1 General

- (1) Unless specified otherwise, or the engineer approves, use materials conforming to the requirements below.

632.2.2 Plant Materials

632.2.2.1 General

- (1) Unless specified otherwise, for all plants use nursery grown stock, transplanted or root-trimmed 2 or more times, according to the kind and size of plants.
- (2) Ensure all plants are typical of their species, have well formed tops and root systems, and are free from injurious insects, plant diseases, or other plant pests. Use plants that are hardy under the climatic conditions at the work site. Furnish plants free from the following defects:
 1. Damage to top, branches, trunk, bark or roots.
 2. Dried out roots.
 3. Prematurely opened buds.
 4. Thin or poor tops or root systems.
 5. Evidence of mold.
 6. Dry, loose, or broken ball of earth in B&B stock.
 7. Dried out or damaged soil mass in B&P or CG stock.

632.2.2.2 Collected and Plantation Grown Stock

- (1) Collected and plantation grown stock shall conform to the current edition of the American Standard for Nursery Stock recommended for general use and adoption by the American Association of Nurserymen, Inc.
- (2) The contractor shall furnish collected and plantation grown plant stock only if specified. If the contract allows collected plant stock, the contractor shall notify the engineer of the source of supply or growing site at least 10 days before digging the plants. Dig all collected plants with a root spread, or ball of earth, at least 1/3 greater than that required for nursery-grown plants of the same species, variety, and size.
- (3) If collected stock is furnished, leave at least 50 percent of the species undisturbed at the collection site unless the engineer approves otherwise.

632.2.2.3 Lining Out Stock

- (1) Lining out stock and seedling trees shall conform to the current edition of the American Standard for Nursery Stock.

632.2.2.4 Substitution

- (1) If the contractor submits written documentation that a specified plant is not obtainable it may make substitution, only with the engineer's approval. The engineer may approve the use of larger plants than those specified, at no cost to the department. The ball or container size or the root spread of the larger size shall be increased proportionally, relative to the specified size.

632.2.2.5 Grading Standards

- (1) Plant stock shall conform to the current edition of the American Standard for Nursery Stock.

632.2.2.6 Plant Inspection and Legal Requirements

- (1) All plant material shipments and deliveries shall comply with State and Federal laws and regulations including Wisconsin Administrative Code, Chapter ATCP 21 governing the inspection, shipping, selling, and handling of plant stock. Attach a tag or label bearing the name and address of the licensed dealer or nurseryman and a certification that the material is from an officially inspected source to each shipment or delivery of plant material. File it with the engineer upon arrival of the plant material at the project site.

632.2.2.7 Plant Names and Labels

- (1) The names and labels used in the plans and specifications conforms, with few exceptions, to the current edition of Standardized Plant Names as adopted by the American Joint Committee on Horticultural Nomenclature.
- (2) Ensure all plants are true to name, and secure a legible label to each bundle or plant indicating the name and size of the plant material.

632.2.2.8 Plant Approval

- (1) The contractor shall furnish to the engineer a written list of the sources from which the contractor proposes to obtain plant materials. Furnish this list to the engineer within 15 days of the award of the contract. Do not alter this list without the engineer's approval.
- (2) The engineer shall approve all plants. The engineer may inspect plants at the grower's nursery or at the place of collection, or at the collector's holding site. The engineer may tag representative plants at the grower's nursery. Although the engineer may approve plants at the source, they may still reject plants at the project site.
- (3) Replace all rejected plants with acceptable plants of the same species, variety, and size, unless the engineer directs otherwise.

632.2.2.9 Digging, Handling, and Packing Plant Stock

632.2.2.9.1 General

- (1) The contractor shall dig all plant stock and handle with care and skill to prevent injuries to the trunk, branches, and roots, and shall pack in an engineer-approved manner to ensure the plants arrival at the project site undamaged and in good condition.
- (2) Transport the plant stock in enclosed vehicles or in a way that protects the plant tops from drying.
- (3) Handle all plants furnished with earth balls or in containers by the ball or container.

632.2.2.9.2 Bare Root Stock (BR)

- (1) If furnishing plant stock BR protect the roots against drying out during moving by using moist sphagnum moss, straw, or other suitable material, and cover with canvas or other suitable covering in an engineer-approved manner.

632.2.2.9.3 Balled and Burlapped Stock (B&B)

- (1) If furnishing plant stock B&B, move the plant with a freshly dug ball of earth so firmly wrapped in burlap that on delivery the soil ball is still firm and compact around the small feeding roots. Ensure each ball is large enough to encompass all the fibrous feeding roots necessary to ensure successful recovery and development of the plant. The minimum sizes of balls, ball depth, and diameters, and increased ball sizes for collected stock shall conform to recommended balling and burlapping specifications, in the current edition of the American Standard for Nursery.

632.2.2.9.4 Balled and Potted Stock (B&P)

- (1) If furnishing plant stock B&P, furnish plants dug from the growing site with the roots contained in a compact unbroken ball of earth and placed in a plantable fiber container. The size and shape of the earth ball shall conform to the approximate size and shape of the container. Place the stock in the container so that the plant root collar is approximately one inch (25 mm) below the top of the container. Fill all voids at potting time with native soil. The minimum ball size shall equal the ball size for B&B stock in the current American Standard for Nursery Stock for the plant specified.

632.2.2.9.5 Container Grown Stock (CG)

- (1) If furnishing plant stock CG, furnish well-rooted stock established in containers. This means that when the container is removed the root soil mass shall retain its shape but shall not have grown in the container long enough to become container bound. Use sufficiently rigid containers that retain their shape and protect the plant root system during shipping and handling. For container size, conform to the specifications for CG stock as stated in the current edition of the American Standard for Nursery Stock.

632.2.2.9.6 Machine Transplanted Stock (MT)

- (1) For plants furnished or transplanted as MT stock, the contractor shall move plants from the growing site to selected sites within the right-of-way using a tree-transplanting machine. Use a machine capable of digging and removing from the ground an unbroken mass of earth of the specified size and shape. It shall also lift and transport the mass of earth supporting the specified size plant and containing its roots in an undisturbed condition. The machine shall hold the soil mass and roots in the undisturbed condition until the tree is lowered into position in a planting hole pre-dug by the same machine.

632.2.3 Backfill Material

632.2.3.1 Compost

- (1) Provide an engineer-approved standard commercial compost of cattle, sheep, or poultry manure or other organic material.

632.2.3.2 Peat Moss

- (1) Peat moss shall consist of at least 75 percent of partially decomposed stems and leaves of sphagnum, hypnum, polytrichum, and other mosses in which the fibrous and cellular structure is still recognizable. Provide peat moss that is brown to black in color and nearly free of decomposed colloidal residue, wood, and other foreign matter. The engineer will not accept humus peat. Peat moss shall have the following characteristics:
 1. Moisture content shall not exceed 60 percent by weight.
 2. Ash content shall not exceed 20 percent, based on the oven dry weight of the material.
 3. The pH value shall not exceed 7.0 or be less than 3.2 at 77 F (25 C).
 4. Water holding capacity shall at least equal 400 percent, by weight, on an oven dry basis.
- (2) Upon request, the contractor shall furnish the engineer with a representative sample of peat moss for testing according to the Federal specification Q-P-166e for peat moss, peat humus, and peat reed-sedge.
- (3) The contractor shall furnish the engineer with a certificate stating the type of peat moss, the brand name and the country or place of origin. If packed in bales and if using bale size to determine quantities for mixing, the certificate shall also contain the cubic feet (m³) of compressed bale size, the compression ratio, and the approximate weight of the bales. The engineer will not require a certificate if this information is marked on the bales.

632.2.3.3 Topsoil

- (1) For topsoil, conform to the topsoil specified in [625.2](#) and to the gradation requirements specified in [625.3.3](#).
- (2) Salvage topsoil from the plant hole excavation if it conforms to the above requirements. The contractor may use the sod from the plant hole excavation for backfill, together with topsoil, provided it is thoroughly broken into small pieces and used in limited quantities near the bottom of the plant hole in a manner that does not place it in contact with the small feeder roots.

632.2.3.4 Planting Mixture

- (1) The planting mixture consists of a blend of peat moss, topsoil, and sand in a ratio of 1:1:1 by volume. Blend fertilizer into the mixture at the rate of 4 pounds (2.5 kg) of fertilizer to each cubic yard (m³) of mixture.
- (2) The peat moss shall conform to [632.2.3.2](#) and topsoil to [632.2.3.3](#), and have 100 percent passing a 3/8-inch (9.5 mm) sieve. Obtain the engineer's approval for the sand.

632.2.4 Fertilizer

- (1) Fertilizer shall conform to [section 629](#) and to the following:

632.2.4.1 Fertilizer for Planting Mixtures

- (1) Unless specified otherwise, use a superphosphate fertilizer conforming to the following minimum requirements:

Nitrogen	0%
Phosphoric Acid.....	20%
Potash	0%

632.2.4.2 Fertilizer for Plant Holes

- (1) For fertilizer used in plant holes, provide water soluble fertilizer contained in a micropore slow release polyethylene packet. Each packet shall contain a minimum of one ounce (28 g) of fertilizer.

- (2) The fertilizer shall conform to the following minimum requirements:

Nitrogen, not less than	16%
Phosphoric Acid, not less than	8%
Potash, not less than	16%

632.2.4.3 Fertilizer for Wood Chip Mulch

- (1) If using fertilizer on areas receiving wood chip mulch, use a slow release ureaform fertilizer having at least 38 percent nitrogen.

632.2.5 Water

- (1) Provide water that is free from impurities or substances that might injure the plant.

632.2.6 Mulch

- (1) Mulch, if specified, consists of shredded bark, wood chips, peat moss, or other suitable material, that is substantially free of noxious weed seeds and objectionable foreign material. Wood chips are the type obtained from any standard wood or brush-chipping machine. Obtain the engineer's approval for the type of mulch used.

632.2.7 Wrapping

- (1) Wrapping, if specified, consists of a 2-ply waterproofed crepe tree wrapping paper, laminated with a layer of pliable asphaltic material.

632.2.8 Wound Dressing

- (1) Wound dressing, if required, consists of asphalt base tree paint or other acceptable material suitable for applying by brushing, or spraying on bruised or cut surfaces of plants.

632.2.9 Rodent Protection

- (1) Rodent protection consists of aluminum or other metal commercial window screening material.

632.2.10 Bracing and Guying Materials

- (1) If specified, these materials consist of the wood or steel stakes, wire, soft rope or straps, turnbuckles, and other material needed to perform the work. Provide stakes of solid durable wood approximately 2 inches by 2 inches (50 mm by 50 mm) and of the required length, except that the contractor may use engineer-approved steel posts of the required length for bracing stakes.
- (2) For trees of 4 inches (100 mm) or less in diameter use a good quality 11 or 12 gauge (3 mm) diameter steel wire and 9 or 10 gauge (4 mm) diameter steel wire for trees over 4 inches (100 mm) in diameter. Use a suitable turnbuckle for adjusting the wire tension with the larger wire.

632.2.11 Anti-Desiccant

- (1) Anti-desiccant, if specified, shall consist of an engineer-approved emulsion that provides a film over plant surfaces permeable enough to allow transpiration.

632.2.12 Vegetation Control Herbicide

- (1) Vegetation control herbicide, if specified, consists of a post-emergence herbicide that, if applied to leaves and stems of vegetation, is absorbed and translocated to all parts of the plant including roots and underground stems and is by this means capable of killing the entire plant. Provide a water-soluble herbicide that deactivates on contact with soil, and leaves no harmful residue.

632.2.13 Selective Pre-emergence Herbicide

- (1) The selective pre-emergence herbicide, if specified, shall control plants emerging from seed, but have no harmful effect on established plants if applied at recommended rates. The material shall resist leaching and remain effective throughout one growing season. Provide the selective pre-emergence herbicide in liquid or wettable powder form.

632.2.14 Weed Barrier Fabric

- (1) Furnish geotextile fabric for weed barrier conforming to the following:

TEST	METHOD	VALUE
Minimum weight	ASTM D 3776	0.328 oz/ft ² (100 g/m ²)
Minimum grab tensile strength	ASTM D 4632	80 lb (350 N)
Minimum apparent breaking elongation	ASTM D 4632	45%
Minimum puncture strength	ASTM D 4833	35 lb (150 N)
Minimum trapezoid tear strength	ASTM D 4533	27 lb (120 N)
Maximum apparent opening size	ASTM D 4751	No. 40 sieve (425 µm)
Minimum permittivity, s ⁻¹	ASTM D 4491	1.97

- (2) The geotextile fabric, if specified, consists of a material that allows moisture and air permeability, but prevents the growth of weeds and grasses. The fabric shall consist of non-woven polyester, polypropylene, stabilized nylon, polyethylene, or polyvinylidene chloride. All shall have the minimum strength values in the weakest principal direction.
- (3) The contractor shall not use a needle punched non-woven material geotextile fabric.

632.15 Equipment

- (1) The contractor shall provide sufficient watering equipment, including tanks, pumps, hoses, and accessories to fully perform all the watering required for care in [632.3.19](#). The contractor shall determine the capacity and adequacy of this equipment based on supplying approximately 20 gallons (80 L) of water per large tree, 10 gallons (40 L) per small tree, 5 gallons (20 L) per shrub and 2 1/2 gallons (10 L) per vine or sumac plant for each required watering. Provide a source of water capable of supplying the foregoing amounts.

632.3 Construction

632.3.1 General

- (1) The normal spring planting season for all plants shall extend to June 1. The normal fall planting season for all plants except evergreens begins on October 1. Perform fall evergreen planting between September 1 and October 1. Unless approved otherwise, the contractor shall not plant if the ground is frozen or if the soil is unsatisfactory for planting. The contractor shall not plant if the temperature is below freezing unless protecting the plant roots to prevent damage.
- (2) Do not drag, lift, or pull balled and burlapped plants by the trunk, branches, or foliage. Do not drop or handle in any manner that damages the ball or the plant.

632.3.2 Delivery and Temporary Storage

- (1) At least 3 days before each delivery of plant material to the holding or project site, the contractor shall notify the engineer of this delivery.
- (2) If possible, plant the plants on the day of delivery at the project site. If this is not possible, temporarily store the plant stock by heeling-in or by placing in a well-ventilated, cool, moist storage place and adequately protect against drying by using moist sphagnum moss, straw, or other suitable covering around the roots of BR stock and the balls of B&B stock.
- (3) Space all plants growing in pots or containers to provide for air circulation and reasonably unrestricted top spread. Water and otherwise care for potted and container-grown plants as necessary to keep them in a healthy growing condition while in storage.
- (4) If heeling-in, place bare root plants in a spade depth trench, fully cover their roots with damp topsoil, and protect from the sun and wind. The contractor shall properly care for all heeled-in plants. Plants shall not remain heeled-in from one planting season until the next.

632.3.3 Layout of Planting

- (1) Unless specified otherwise, the engineer will stake out the location of plant holes or beds.

632.3.4 Excavation of Plant Holes

- (1) Center the plant holes at the location stake, unless the engineer allows otherwise.
- (2) Excavate the plant hole, except for MT stock, to at least the minimum dimensions the plant data chart included in the plans show or as the engineer directs. However, the minimum diameter of the plant hole must be at least twenty-four inches (600 mm) greater than the diameter of the ball, container, or roots, for the full depth of the plant hole. The depth of hole shall equal the height of the ball, pot, or container, so that the plant root collar is at ground level when the plant is in its final position and resting on undisturbed ground. Except, if placing the plant in heavy soils, then make the hole deep enough so that the plant root collar is 2 inches (50 mm) above the ground level after planting.
- (3) Unless soil conditions make it impossible, dig the planting holes for MT plants by the tree-moving machine and make them approximately the same size and shape as the soil mass containing the root system of the machine moved plant.
- (4) Keep the sod and topsoil suitable for backfilling separate from the excavated subsoil.
- (5) If planting on a slope, measure the minimum depth of the plant hole from the downward side of the slope at the hole.
- (6) If it is necessary to suspend planting operations until the following planting season, backfill any open plant holes before suspending the work.

632.3.5 Pruning

- (1) Perform pruning according to ANSI A300 standard practices for tree care operations-tree, shrub, and other woody plant maintenance. Prune so that the plant retains its natural form. Make all cuts immediately above the bark ridge and branch collar to leave the ridge and collar intact for healing. The contractor shall not prune evergreen plants except to remove dead or broken branches, or multiple leaders. Treat cut surfaces on oak trees as specified for cut surfaces and abrasions in [201.3](#).
- (2) Cut off smoothly the bruised or broken parts of large or fleshy roots and branches that are dead, broken, or damaged otherwise, before planting. Perform all other pruning near the end of the plant establishment period in mid-to-late August, but before the final inspection. Unless specified otherwise, or the engineer directs, prune deciduous trees by removing branches that compete with the dominant central leader, and thin all deciduous plants as necessary to improve the branch structure of the plant.

632.3.6 Anti-Desiccant

- (1) If specified, apply anti-desiccant to evergreen plants before or at the time of planting, and to BRP plants before shipping from the storage place. Apply it to plants being transplanted before they are transplanted. Apply the emulsion at the rate and method the manufacturer recommends.

632.3.7 Planting

- (1) Plant all BR, B&B, BRP, B&P, CG, and MT plants, unless directed otherwise, according to the method specified below. If possible, protect BR plants against drying by keeping the roots covered with a canvas or other suitable covering until planted.
- (2) Place the plant in the plant hole with its most desirable face towards the most prominent view and hold it in a vertical position. Spread the roots of BR plants to their approximate natural position and prune as required. Place B&B plants while in their wrapped ball. Move and handle only by the ball. Set the plant so that, after settling, the plant root collar is at or 2 inches (50 mm) above the surrounding ground level, as specified above in [632.3.4](#).
- (3) Unless specified otherwise, backfill the plant hole with topsoil composed of 6 parts soil to one part compost by volume. Place this soil compost mixture in layers around the roots or ball. Carefully tamp each layer in place in a manner that avoids injuring the roots or ball or disturbing the plant position. Remove the burlap and other wrapping materials from the top one-half of B&B plants. Once approximately 2/3 of the plant hole is backfilled, fill the hole with water and allow the soil to settle around the roots. After the water is absorbed, fill the plant hole with topsoil and tamp lightly to grade. Bring any settlement to grade with the topsoil.

- (4) Fill holes made for MT plants to about 1/2 the hole depth with slurry made from a 1:1 mixture of water and compost by volume. Place the slurry in the hole just before placing the tree in the hole. After removing the machine, backfill any voids remaining with topsoil. To facilitate watering, auger vertical holes around the periphery of the tree just inside the ball limits. Space the holes equally a maximum of 4 feet (1.2 m) apart. Make each hole deep enough and large enough to accept a perforated pipe 42 inches (1.1 m) long with a 2-inch (50 mm) inside diameter. Insert the perforated pipes into the holes immediately after augering. Make the top of the pipe flush with the top of the mulch once in its final position. Leave the pipes in place after the tree is established.
- (5) After the plantings are in place at least 2 days, but not more than 5, inspect the plantings. Adjust plant depth and plumb as necessary, and place all additional required backfill. During the inspection period, thoroughly water all inspected plants and remove all twine or rope and labels attached to trunks or branches.

632.3.8 Fertilizing

- (1) Use fertilizer, if specified, as follows:

632.3.8.1 Fertilizer for Planting Mixtures

- (1) Add fertilizer to the planting mixtures in a manner that uniformly incorporates it at the rate of 4 pounds (1.8 kg) of fertilizer per cubic yard (m³) of mixture.

632.3.8.2 Fertilizer for Plant Holes

- (1) Uniformly space the number of packets specified on the plans in each plant hole around the outside of the plant hole during backfilling. Place the packets as the planting detail sheet shows after partially completing the backfilling. Place them at least 6 inches (150 mm) below the final grade of the backfill material.
- (2) If specified for MT plants, equally space the packets around the hole in niches dug into the plant hole wall between 9 and 18 inches (225 to 450 mm) below the soil surface.

632.3.8.3 Fertilizer for Wood Chip Mulch

- (1) If specified, uniformly spread fertilizer for wood chip mulch over the mulch, or soil surfaces to be mulched, at the rate of 4 pounds per 1000 square feet (2 kg/100 m²).

632.3.9 Mulching

- (1) Place approximately 3 inches (75 mm) of mulch, if specified, over the backfilled plant hole or plant bed within the specified area after performing all necessary backfilling and adjustment, unless specified otherwise. Pull mulch back 3 to 6 inches from tree trunk. Place mulching material within 5 days of the second watering required for planting under [632.3.7](#). Ensure areas receiving mulch are free of living weeds and grasses before applying mulch.

632.3.10 Vegetation Control Herbicide

- (1) If specified, apply vegetation control herbicide according to manufacturer's instructions to unwanted weeds and grasses and in plant bed areas as the plans designate. Allow a minimum of 10 days between the application and seeding or digging. The engineer may require mowing the areas before treating, or may vary the above requirements to obtain the best results if in the engineer's judgment temperature, rainfall, and other conditions warrant this action. The contractor may use the herbicide to control or destroy weeds and grasses in other mulched areas at the contractor's discretion with the engineer's approval.

632.3.11 Selective Pre-Emergence Herbicide

- (1) Apply selective pre-emergence herbicide, if specified, according to manufacturer's instructions for surface application to plant bed areas the plans show just before applying the mulch.

632.3.12 Wrapping

- (1) If wrapping is specified, wrap the tree trunks with wrapping material overlapping 1 1/2 inches (38 mm), wound from the ground line to the lowest main branches. Secure the wrapping in at least 3 places, including the top, middle, and bottom, with a biodegradable tie or tape. Wrapping plants as soon as practical after planting.

632.3.13 Rodent Protection

- (1) If required, apply the materials specified in [632.2.8](#) for rodent protection to the plants. Place rodent protection material around each tree trunk, with the bottom of the material resting on the soil surface, and the top a minimum of 4 feet (1.2 m) above the surrounding earth surface, or up to the lowest branches on small trees. Wrap the rodent protection loosely around the tree trunk and staple to itself with 3 rows of staples. Space the staples within each row at maximum 6 inches (150 mm) intervals along the seam.

632.3.14 Bracing

- (1) If specified, brace trees with a stake driven into the ground near the base of the tree to a depth of 2 or 3 feet (600 to 900 mm), or until sufficiently solid to support the tree. Stakes shall extend upward to about 6 inches (150 mm) below the lowest main branches. Fasten the tree to the stake by means of a soft rope or strap in a manner that avoids injuring the tree. Allow 1 to 3 inches (25 to 75 mm) of movement by the trunk.

632.3.15 Guying

- (1) If specified, guy the trees with 3 wires whose upper ends are attached to soft ropes or straps that encircle the tree trunk, just above the lowest main branches of deciduous trees and at a point above the ground line of 2/3 the height of evergreen trees. Anchor the lower ends to stakes set in the ground around the tree, equal distance apart and at a distance from the tree of approximately 3/4 the distance from the ground to the upper point of fastening. Notch the anchor stakes to prevent the wire from slipping and drive them into the ground, at a slight angle away from the tree, to a depth of 18 inches (450 mm) or more until solid. Stakes shall extend 3 inches (75 mm) above the ground.
- (2) Draw the wires taut to equal tension by twisting or using turnbuckles, and fasten securely, with the trunk of the tree remaining in a vertical position. Allow 1 to 3 inches (25 to 75 mm) of movement by the trunk.

632.3.16 Disposal of Excess and Waste Material

- (1) Remove and dispose of all excess excavation, waste materials, or other debris.

632.3.17 Weed Barrier Fabric

- (1) Place geotextile fabric on areas the plans show or the engineer designates before placing the mulch. Lay the fabric flat on the smoothed soil and fit as close to the plants as possible. Provide a 4-inch (100 mm) overlap at adjoining sheets. On all slopes, secure the fabric with T-shaped steel pin anchors sufficiently long to prevent the fabric from moving.

632.3.18 Establishing and Replacing Plants

632.3.18.1 Plant Establishment Period

632.3.18.1.1 General

- (1) A plant establishment period of 2 years shall follow the completion of planting, unless the special provisions specify a one-year period.

632.3.18.1.2 Two Growing Season Plant Establishment Period

- (1) The plant establishment period shall extend until October 15 of the second full growing season.

632.3.18.1.3 One Growing Season Plant Establishment Period

- (1) The plant establishment period for material planted in the spring shall extend until October 15 of the same year. If planting in the fall, extend this period until October 15 of the succeeding year.

632.3.19 Landscape Planting Surveillance and Care

632.3.19.1 General

- (1) Properly care for all plants from the time of planting until final acceptance of the work.
- (2) Proper care of plants consists of watering, weeding, cultivating, pruning, spraying, tightening braces and guys, retying wrapping, re-mulching, and other work necessary to keep the plants in a neat appearance and healthy growing condition. In addition to the watering required for planting under [632.3.7](#), perform complete watering at 10- to 14-day intervals between May 15 and October 15. The interval is referred to as a care cycle. This interval may lengthen if weather conditions and soil moisture allows. The engineer may order additional watering at any time during the plant establishment period if conditions require.

- (3) Water each plant hole sufficiently at each watering to keep the topsoil backfill material in a moist condition and to keep the plant in a healthy growing condition.
- (4) Remove and dispose of all evergreens and deciduous trees that die during the course of the plant establishment period as their dead condition becomes evident.
- (5) Keep all mulched areas free of all vegetation, except the specified plants, by hoeing, hand weeding, or by using herbicides if the engineer approves.
- (6) String all vines to fences and direct runners toward retaining walls or structures during the plant establishment period.
- (7) Apply pesticides as required to control insects and diseases and to keep the plants in a healthy condition.
- (8) Replace all plants that die or show evidence of dying during the plant establishment period at the earliest appropriate planting time after this condition becomes apparent. The engineer will allow replacements until June 1 of the year in which making the final inspection.
- (9) Remove and dispose of all bracing and guying materials after the final inspection of the plantings.
- (10) Provide one person, called the care specialist, responsible for inspecting and performing the required care. Also provide other personnel, vehicles, equipment, tools, and materials needed to accomplish the inspection and care. Have the care specialist do the following:
 1. Perform care requirements to the satisfaction of the project engineer a minimum of once every two weeks.
 2. Notify the engineer at least two days before the beginning of each care cycle.
 3. Submit a written report to the project engineer after each care cycle. Ensure that the report documents the work performed during the care cycle; the number, type, and location of each plant that was removed or marginal; and other information the project engineer or the specialist deems appropriate.

632.3.19.2 Damages for Failing to Perform

- (1) If the care specialist fails to perform any of the required care cycles as specified [632.3.19.1](#), the department will assess daily damages in an amount the special provisions specify to cover the cost of performing the work with other forces. The department will assess these damages for each day the requirements of the care cycle remain incomplete, except when the engineer extends the required time period.

632.3.20 Acceptance or Replacement of Plant Material

- (1) Near the end of the applicable plant establishment period, but not later than September 15, the engineer will make final inspection of the planting and accept only those plants in a healthy growing condition and conforming to the following minimum requirements:
 - Plant sizes and standards shall adhere to the American Standards for Nursery Stock.
 - All plants are the species specified unless the engineer approves changes. Conform to [632.3.19](#), for proper care of plants.
 - Deciduous trees shall exceed the minimum size of the specified size range and shall have fully matured, average-sized, healthy leaves distributed throughout the branch system as is typical of the species.
 - Deciduous shrubs shall exceed the requirements of the specified size range and have mature, average-sized leaves typically distributed throughout the branch system.
 - Deciduous vines shall have the required number of runners, each exceeding the minimum required length.
 - Evergreens shall exceed the minimum size of the specified size range and all coniferous types shall have fully developed, mature needles, and average-sized buds on current season's growth.
- (2) Remove and replace plants not conforming to the above requirements with satisfactory plants during the current fall planting season or, the engineer may allow them to remain in place. Use the same materials and method of replacement planting specified for the original planting.
- (3) Replacing plant materials shall not extend the plant establishment period.

632.3.21 Contract Time

- (1) The contractor shall not charge contract time during the plant establishment period or when making replacements, unless other contract operations are in progress during the same period.

632.4 Measurement

- (1) The department will measure the Trees, Shrubs, and Vines bid items by the number of plants of each species, variety, and size acceptably completed.
- (2) The department will measure the Landscape Planting Surveillance and Care bid items as each individual care cycle the care specialist acceptably completes.

632.5 Payment

632.5.1 General

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
632.0100	Trees (species and size)	EACH
632.0200	Shrubs (species and size)	EACH
632.0300	Vines (species and size)	EACH
632.9100	Landscape Planting Surveillance and Care (cycle)	EACH

- (2) Payment for the Trees, Shrubs, and Vines bid items is full compensation for providing, transporting, handling, storing, pruning, placing, and replacing plant materials; for excavating all plant holes, salvaging topsoil, mixing, and backfilling; for providing and applying all required fertilizer, weed barrier fabric, mulch, water, wrapping, guys and braces, rodent protection, herbicides and anti-desiccant spray; for removing guys and braces; and for disposing of all excess and waste materials. Payment for the Topsoil bid item used in planting will be as specified in [section 625](#).
- (3) Payment for the Landscape Planting Surveillance and Care bid items is full compensation for all the work required under this bid item. The department will assess damages for failing to perform the required surveillance and care as specified in [632.3.19.2](#).

632.5.2 Payment Schedule

- (1) The department will pay the contract value of the work to the contractor according to the following schedule:
 1. Each time an item or portion of an item is acceptably completed, except for care as specified in [632.3.19](#), the department will pay 65 percent of the contract value of the work for contracts containing a 2 growing season plant establishment period; and the department will pay for 80 percent of the contract value of the work for contracts containing a one growing season plant establishment period.
 2. For contracts with a 2 growing season establishment period, each time an item or portion of an item acceptably completes one growing season, including care, and is satisfactory otherwise, the department will pay an additional 15 percent of the contract value of the work. If an item or portion of an item completes the second growing season, including care, and is satisfactory otherwise, the department will pay the final 20 percent of the contract value of this work.
 3. For contracts with a one growing season establishment period, each time an item or portion of an item completes the growing season, including care, and is satisfactory otherwise, the department will pay the final 20 percent of the contract value of this work
- (2) The department will make final payments upon final acceptance and completion of all work required under the contract.

632.5.3 Reduced Payment

- (1) The department will pay for plants that do not conform to [632.3.20](#) but that the engineer allows to remain in place, at 65 percent of the contract unit price for contracts containing a 2 growing season plant establishment period, and at 80 percent of the contract unit price for contracts containing a one growing season plant establishment period.

SECTION 633 DELINEATOR POSTS AND DELINEATORS

633.1 Description

- (1) This section describes furnishing and erecting delineator posts and delineators, as the plan shows.

633.2 Materials

633.2.1 Steel Delineator Posts

- (1) Provide a flanged channel section post weighing 1.12 pounds per linear foot (1.67 kg/m) or more before zinc coating, and made of steel with the following properties:

Minimum tensile strength.....	50 ksi (345 MPa)
Minimum tensile yield strength	36 ksi (250 MPa)
Minimum elongation.....	5.0 percent in 2 inches (50 mm)
- (2) Provide posts the length, and with mounting holes the size and spacing the plans show. Ensure the posts are symmetrical, well rolled, and free from defects that impair their strength or appearance.
- (3) Hot-dip zinc coat the posts after completing all forming, cutting, punching or drilling. Perform zinc coating according to AASHTO M 111.

633.2.2 Flexible Delineator Posts

- (1) Provide posts from an approved manufacturer listed on the department's approved products list.

633.2.2 Delineator Brackets

- (1) Provide either structural steel or aluminum brackets for mounting delineators on concrete barriers or other structures. For structural steel brackets, conform to [506.2.2](#) and zinc coat the finished bracket as specified in [633.2.1](#). For aluminum brackets, conform to ASTM B 221, alloy 6061-T6. Provide stainless steel self-locking nuts, bolts, and washers conforming to [513.2.2.5](#).

633.2.3 Delineators

633.2.3.1 General

- (1) Furnish delineator units consisting of an approximately 3 inch (75 mm) circular hermetically sealed, acrylic plastic prismatic, reflex reflector, housed in embossed aluminum, and provided with a single grommeted mounting hole or provide a flexible plastic post from the department's approved products list, complete with a 3 inch (75 mm) x 9 inch (225 mm) reflective sheet conforming to [637.2.2.2](#).
- (2) Obtain the engineer's approval for the type and quality of acrylic plastic reflex reflectors used.
- (3) Unless specified otherwise, furnish a delineator conforming to the following:
 1. Provide a housing 0.020 inch (0.50 mm) thick, of 5052-H32, 5052-0 or 3003-H 14 of ASTM B 209 aluminum formed to approximately 3.25 inches (83 mm) in diameter and 0.235 inches (6 mm) in depth to retain the acrylic reflector.
 2. Mark the housing with the part number and the name of the manufacturer.
 3. Provide an expanded aluminum grommet with a 3/16-inch (5 mm) inside diameter expanded within the reflector-mounting hole.
- (4) Furnish a reflector with the following characteristics:
 1. Having a clear plastic base.
 2. Seven square inches (4500 mm²) of reflective area, called the lens.
 3. A heat sealable plastic or plastic-coated metallic foil back, fused to the lens under heat and pressure around its perimeter and the central mounting hole to form a unit sealed against dust, water, and vapor.
 4. For reflector color, use the color specified in the MUTCD.
- (5) Provide a lens with a smooth front surface; free from protrusions or indentations, other than a central mounting hole and identification, with a prismatic pattern on the rear surface, that results in total internal reflection of light. Ensure that the manufacturer's trademark is molded legibly in the lens face.

633.2.3.2 Reflecting Requirements

- (1) Regardless of reflector orientation, the brightness of each reflector shall equal or exceed the following:

DIVERGENCE ANGLE in degrees	ENTRANCE ANGLE in degrees	MINIMUM SPECIFIC INTENSITY in candela/foot-candle (cd/lx)	
		CRYSTAL	YELLOW
0.1	0	115 (10.7)	70 (6.5)
0.1	20	45 (4.2)	25 (2.3)

- (2) The entrance angle is the angle at the reflector between the direction of light incident on it and the direction of the reflector axis.
- (3) The divergence angle is the angle at the reflector between the observer's line of sight and the axis of the incident light beam.
- (4) The engineer will reject reflectors that do not conform to the above minimum intensity values. If 5 percent or more of the tested samples fail, the engineer will reject the entire lot or shipment.

633.2.3.3 Mounting Hardware

- (1) For mounting hardware, use engineer-approved aluminum connectors of a vandal-resistant type, unless specified otherwise.

633.2.3.4 (Vacant)

633.2.4 Temporary Delineators

- (1) Furnish new temporary delineators and new temporary delineator posts conforming to [633.2](#).
- (2) If the engineer approves, the contractor may furnish used posts. Upon contract completion, all temporary delineators and temporary delineator posts become the contractor's property.

633.3 Construction

633.3.1 Erecting Delineator Posts and Brackets

- (1) Under the Delineator Posts bid items, erect steel or flexible plastic posts to support delineators or small signs.
- (2) Under the Delineator Brackets bid item, provide zinc coated steel or aluminum angles or brackets to support delineators mounted on concrete barriers or other structures.
- (3) Set the posts and steel or aluminum brackets for the delineators at the locations and offsets the plans show or the engineer directs.
- (4) Erect the posts to a true vertical position by driving with equipment that does not damage the post. The contractor shall remove and replace all posts bent or damaged otherwise by its own operations at no expense to the department. Drive the posts into the ground according to plan details, unless specified otherwise.
- (5) Mount delineator brackets with stainless steel bolts, anchors, and gaskets if required, according to plan details.
- (6) Under the Delineator Posts Flexible bid item, the curved side of the post is to face in the direction of travel on the roadway.

633.3.2 Installing Delineators

- (1) Under the Delineators bid item, erect reflector units on steel or wood marker posts, or on structures.
- (2) Assemble the delineators in the field, for mounting according to the plans requirements, as single delineators or double delineators.
- (3) Mount the center of the top delineator unit at the height the plans show.
- (4) Attach each delineator unit securely to the supporting steel post. If placing on structures, mount according to plan details.
- (5) If required, attach delineator units to marker posts with aluminum screw-nails according to plan details. Notch the marker post to accept the delineator unit or units, and drill or saw the base of the post if required, all as the plans show.

633.3.3 Temporary Delineators

- (1) Under the Temporary Delineators bid item, provide, install, and remove temporary delineators and temporary delineator posts.

633.4 Measurement

633.4.1 Delineator Posts and Delineator Brackets

- (1) The department will measure Delineator Posts Steel, Delineator Posts Flexible, and Delineator Brackets by each individual post or bracket acceptably completed.

633.4.2 Delineators and Temporary Delineators

- (1) The department will measure Delineators and Delineators Temporary by each individual reflector acceptably completed.

633.5 Payment

633.5.1 General

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
633.0100	Delineator Posts Steel	EACH
633.0200	Delineator Posts Flexible	EACH
633.0500	Delineators	EACH
633.1000	Delineator Brackets	EACH
633.1100	Delineators Temporary	EACH

633.5.2 Delineator Posts

- (1) Payment for Delineator Posts Steel and Delineator Posts Flexible is full compensation for providing and erecting the posts; and for removing and disposing of surplus materials, contractor damaged posts, and debris.

633.5.3 Delineators

- (1) Payment for Delineators is full compensation for providing and mounting the delineator, including bolts, nuts, washers, screw-nails, or other connectors.

633.5.4 Delineator Brackets

- (1) Payment for Delineator Brackets is full compensation for providing and erecting the brackets, including anchors, bolts, and gaskets.

633.5.5 Temporary Delineators

- (1) Payment for Delineators Temporary is full compensation for providing, installing, and removing delineators and delineator posts.
- (2) The department will not pay for replacement of temporary delineators and temporary delineator posts damaged during construction.

SECTION 634 WOOD AND TUBULAR STEEL SIGN POSTS

634.1 Description

- (1) This section describes furnishing and erecting wood and tubular steel posts to support signs.

634.2 Materials

634.2.1 General

- (1) Furnish posts conforming to [507.2.2](#) for lumber and timber, and the following:
- (2) Furnish posts conforming to the dimensions the plans show, and having 4 sides (S4S) surfaced.

634.2.2 Species of Wood

- (1) Select posts from one of the softwood species listed for sawed posts for beam guard in [614.2.4.1](#).

634.2.3 Grade Requirements

- (1) Unless specified otherwise, use posts conforming to the bid items Beams and Stringers or Joists and Planks with a minimum stress grade rating of 1200 fb (8280 kPa).

634.2.4 Preservative Treatment

- (1) Preservative treat all posts, and unless specified, use one of the waterborne preservatives specified in preservative treatments, [507.2.2.6](#). Apply the preservative treatment by the pressure process specified in [507.2.2.6](#).

634.2.5 Tubular Steel

634.2.5.1 General

- (1) Furnish tubular steel sign post assemblies consisting of 3 telescoping square steel tubes as follows:
1. Breakaway upper tube for mounting the sign.
 2. Inside anchor tube.
 3. Outside anchor tube.
- (2) Fabricate the tubular components using structural quality 12-gauge strip steel conforming to ASTM designation A570, grade 50 with an average minimum yield strength, after cold-forming, of 55 000 psi (380 MPa). Punch holes on all 4 sides for the full length as the plans show. Provide corner radii of approximately 5/32 inches (4 mm) and conform to other dimensions and tolerances as follows:

COMPONENT DIMENSIONS AND TOLERANCES^[1]

COMPONENT	OUTSIDE DIMENSIONS inches (mm)	OUTSIDE DIMENSION TOLERANCE inches (mm)	ALLOWABLE TWIST ^[2] inches/3 feet (mm/m)
UPPER TUBE	2.00 x 2.00 (50 x 50)	+/-0.008 (0.200)	+/-0.062 (1.570)
INSIDE ANCHOR TUBE	2.25 x 2.25 (56 x 56)	+/-0.010 (0.300)	+/-0.062 (1.570)
OUTSIDE ANCHOR TUBE	2.50 x 2.50 (63 x 63)	+/-0.010 (0.300)	+/-0.075 (1.910)

^[1] Measure at least 2 inches (50 mm) from the ends of the tubes.

^[2] Hold one side on a flat surface plate and measure the twist at the corner 3 feet away.

- (3) Hot-dip galvanize each tube according to ASTM A653 grade 90. Treat corner welds and cut ends with cold-galvanized organic zinc paint as manufacturer recommends.
- (4) The engineer will inspect sign post assemblies before installation. Ensure that the assemblies fit together without damaging the coatings. Replace scratched or otherwise damaged components at no expense to the department.

634.2.5.2 Upper Tube

- (1) Furnish upper tubes fabricated to the lengths the plans show. If the plans show colored stock clean and phosphate before painting with an acrylic paint using an electrodeposition process followed by baking.

634.2.5.3 Anchor System

- (1) Assemble the anchor system, consisting of the inner and outer anchor tubes, as the plans show with a 3 inch (76 mm), grade 5 zinc plated bolt and nut. Ensure the holes of the 2 tubes match.
- (2) Use an 18-inch (450 mm) anchor system for all poured concrete installations. Use a 36-inch (900 mm) anchor system for other installations.

634.3 Construction

634.3.1 Wood Posts

- (1) Set and laterally position the wood posts for supporting roadside signs as the plans show, or as the engineer directs.
- (2) Upon adequate advance request from the contractor, the engineer will establish and stake the location for the sign, and establish the pavement elevation if the finished pavement is not in place.
- (3) Erect posts in a true vertical position. Excavate the holes for posts to the depths and at the locations the plans show, or as the engineer directs. After positioning the post in the hole, backfill the hole with the excavated material. Place and compact this material in 6-inch (150 mm) layers.
- (4) The contractor shall not paint wood posts for signs.
- (5) Remove and dispose of all excess excavation, surplus material, and debris resulting from the installation, and repair and restore all other work damaged by installation operations.

634.3.2 Tubular Steel Sign Posts

- (1) Obtain the engineer's approval and locate all underground facilities before installing the tubular steel sign post assemblies. Install assemblies oriented to the direction of traffic as the plan details show to ensure that the system meets the yielding breakaway design requirements. Locate assemblies where the plans show or where the engineer directs. Do not install until the finished grade is established.
- (2) Install either a 18-inch (450 mm) or 36-inch (900 mm) anchor system as follows:
 1. For poured concrete installations at least 4 inches (100 mm) thick, use the 18-inch (450 mm) anchoring system. Wrap the anchor with tape to prevent concrete from plugging the anchor.
 2. For other installations, use the 36-inch (900 mm) anchoring system. For installations in hardened concrete do one of the following:
 - 2.1 If the plans show 12-inch (300 mm) by 12-inch (300 mm) box outs, install in the center of the box.
 - 2.2 The contractor may core the concrete with a 3 1/2 inch (89 mm) minimum diameter hole. Grout in the anchor using a quick set cement.
- (3) Install all anchor sections so that a length of one to 2 inches (25 - 50 mm) remains above the finished grade. Leave one hole of the anchor system exposed 1 inch (25 mm) above grade for connecting the upper tube with a 3/8-inch (9.5 mm) zinc plated corner bolt and nut.
- (4) Attach the required sign panels as the plans show or as the engineer directs. Mount the signs on the upper tube with the end 1/2 inch (13 mm) lower than the top of the sign. Place the entire tubular steel sign post assembly in a true vertical position and correctly align for proper visibility for the direction of traffic. Cut upper tubes to provide the sign height the plans show or the engineer directs. Treat all exposed post surfaces after installation with cold-galvanized organic zinc paint according to the manufacturer's instructions.

634.4 Measurement

- (1) The department will measure the Posts Wood bid items as each individual post acceptably completed.
- (1) The department will measure the Posts Tubular Steel bid items as each individual post assembly, including each section and anchor, acceptably completed.

634.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
634.0400 - 0699	Posts Wood (size) (length)	EACH
634.0800 - 0899	Posts Tubular Steel (size) (length)	EACH

- (2) Payment for the Posts Wood bid items is full compensation for providing, hauling, and placing the posts; for excavating and backfilling post holes; and for removing and disposing of surplus material.
- (3) Payment for the Posts Tubular Steel bid items is full compensation for providing, hauling, and placing the posts; treating cut post ends; and providing hardware and anchors. The department will not pay for replacing damaged posts or upper tube cut-offs.

SECTION 635 STRUCTURAL STEEL SIGN SUPPORTS

635.1 Description

- (1) This section describes furnishing and erecting steel sign supports.

635.2 Materials

- (1) Furnish materials conforming to the following:

High-strength structural steel	506.2.2.3
Charpy V-notch requirements	506.2.2.4
Welding materials	506.2.3.11

- (2) Conform to ASTM A 709, grade 50 for all steel sign supports except if the contract requires high-strength structural steel conforming to ASTM A 709 grade 50W, A 588.
- (3) Furnish high-tensile strength bolts conforming to AASHTO M 164, type 1 or 2, or to type 3 if A 709 grade 50W steel is required. Furnish suitable nuts and washers. Furnish nuts conforming to AASHTO M 291. Furnish washers conforming to AASHTO M 293. Mechanically zinc coat type 1 or 2 bolts, and their nuts and washers, according to AASHTO M 298, class 65. Furnish fasteners of the dimensions the plans show.
- (4) Furnish structural steel sign supports intended to support ground mount signs made of steel supports fabricated and erected according to the plans and specifications.

635.3 Construction

635.3.1 General

- (1) Use construction methods including fabrication, inspection, erection, mill test reports, and shop drawings, conforming to those specified in [506.3](#) for steel bridges and the following:

Shop drawings	506.3.2
Bolt holes	506.3.5
Bolts and bolted connections	506.3.12
Welding	506.3.19
Mill inspection and tests	506.3.21
Field inspection	506.3.25
- (2) Stake or mark the sign location and erect the supports as specified for placement and orientation in [637.3.2.2](#).

635.3.2 Fabrication

- (1) Fabricate structural steel sign supports according to plan details.
- (2) Zinc coat sign supports fabricated from ASTM A 709 grade 50 steel, except zinc coat the encased stub lengths the plans describe, according to AASHTO M 111 after completing all cutting, drilling, punching, and welding. Ensure that the zinc coating withstands 8, one-minute dips in the Preece test solution, ASTM A 239.

635.3.3 Erection

- (1) Allow concrete footings to cure for at least 7 days before erecting the sign support.
- (2) Erect sign supports according to details the plans show.

635.3.4 Repairing Damaged Zinc Coating

- (1) Repair all zinc coating chipped or damaged during handling or transporting by metallizing as specified in AASHTO M 36 for repairing damaged coating; or repair by field coating, apply a paste consisting of department-approved zinc powder and flux with a minimum amount of water; or use an engineer-approved stick or bar containing zinc powder and flux. Thoroughly clean the places receiving coating before applying the zinc compound. Heat the surface receiving coating to a temperature, about 600 F (315 C) that melts all metallics in the paste when applied to the heated surface. Take extreme care to cause no damage to the zinc coating surfaces during heating.
- (2) The contractor may apply an acceptable zinc-rich paint to a minimum dry-film thickness of 0.005 inches (0.13 mm), instead of the above methods, with the engineer's specific approval. Thoroughly clean the damaged and adjacent areas before applying.

635.4 Measurement

- (1) The department will measure Sign Supports Structural Steel HS by the pound acceptably completed. The measured quantity equals the total weight before applying any zinc coating, including the weight of plates, bolts, nuts, and washers, included in the work. Required brass shims are incidental to the cost of the work.
- (2) The department will measure structural steel as specified for steel bridges in [506.4](#).

635.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
635.0200	Sign Supports Structural Steel HS	LB

- (2) Payment for Sign Supports Structural Steel HS is full compensation for providing all materials, including encased stub lengths or anchor bolts; for fabricating, including all cutting, preparing, welding, and zinc coating; and for transporting and erecting.
- (3) Payment does not include constructing concrete footings, or furnishing, or placing signs, or sign lighting fixtures.

SECTION 636 CONCRETE SIGN SUPPORTS

636.1 Description

- (1) This section describes constructing concrete footings for supporting structural steel sign supports or sign bridges. Structural steel sign supports and sign bridges are described in [section 641](#).

636.2 Materials

- (1) Use materials conforming to the following requirements:

Concrete [section 501](#)
Steel reinforcement..... [section 505](#)

- (2) Furnish grade A, A-FA, A-S, A-T, A-IS, or A-IP concrete conforming to [501.2](#).

636.3 Construction

636.3.1 General

- (1) Construct according to those methods specified for culverts and retaining walls in [section 504](#) and as specified below.
- (2) Except as provided otherwise, construct concrete footings for structural steel sign supports and sign bridges according to the dimensions and at the locations the plans show.
- (3) The contractor shall locate the footing so that after properly erecting the sign support or sign bridge and after installing the sign or signs they are at the position, elevation, and orientation the plans, and specifications specify, or as the engineer directs.
- (4) If the contract requires, install a 5/8-inch (16 mm) by 10 foot (3 m) copper clad ground rod at the sign support. Install the rod next to the support or as the engineer directs.

636.3.2 Excavation

- (1) Before beginning any excavation, locate all existing underground cable, utility, or drainage structures in the vicinity and conduct operations to avoid damaging them.
- (2) Excavate the footing to the required depth and as close to the neat lines as possible, with minimal disturbance to adjacent soil.

636.3.3 Placing Concrete

- (1) Place the concrete for the footing in the excavation, against the soil without forming, except as specified otherwise below.
- (2) Place concrete to the initial height the plans show. Only form the portion of the sign bridge footing that extends above the ground.
- (3) If steel reinforcement is required, secure it in place before placing the concrete.
- (4) Set and secure the anchor bolts and post stubs at their proper location until the concrete hardens.
- (5) Construct the footing shafts to extend above the finished ground elevation a maximum of one inch (25 mm) according to plan details. Line the upper 18 inches (450 mm) of the shaft with a disposable casing to ensure a concrete shaft of uniform diameter. For the upper surface, provide a level plane finished true to grade.
- (6) If the engineer determines that the possibility of cave-ins, or soil displacement from the walls exists, or if necessary to shut off seepage water, then line the remaining depth of the footing shaft with a suitable casing. Ensure casings are of ample strength to withstand handling stresses, concrete pressure, and the pressure of surrounding soil materials. If removing the casings, withdraw them while placing the footing concrete or immediately following concrete operations. If removing the casing during the concrete operation, place at least 2 feet (600 mm) of concrete before starting to pull the casing, and maintain a head of concrete of from one to 2 feet (300 mm to 600 mm) during the pulling operation. Take care when pulling the casing to prevent moving the stub posts or anchor bolts, reinforcement steel, and upper casing, and to prevent any appreciable amount of soil from mixing with the concrete.
- (7) If required, cast the electrical conduit in the footing according to the plan details.

636.3.4 (Vacant)

636.3.5 Clean-Up

- (1) After completing work and before acceptance, remove and dispose of all excess excavation and surplus or discarded materials, and restore all work or property damaged during operations.

636.4 Measurement

636.4.1 Concrete

- (1) The department will measure Sign Supports Concrete Masonry by the cubic yard acceptably completed. The department will base measurement on the dimensions the plans show or that the engineer orders in writing. The department will not measure concrete placed outside the designated dimensions.

636.4.2 Steel Reinforcement

- (1) The department will measure the Sign Supports Steel bid items by the pound acceptably completed. The department will compute the weight as specified for bar steel reinforcement under [505.4](#).

636.5 Payment

636.5.1 General

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
636.0100	Sign Supports Concrete Masonry	CY
636.0500	Sign Supports Steel Reinforcement	LB
636.1000	Sign Supports Steel Reinforcement HS	LB
636.1500	Sign Supports Steel Coated Reinforcement HS	LB

636.5.2 Concrete

- (1) Payment for Sign Supports Concrete Masonry is full compensation for providing, transporting, placing and curing the concrete; for providing and removing casing if applicable; for providing required ground rods; for all required excavating; for placing post stubs or anchor bolts, and for providing and placing electrical conduit if required; for cleaning-up, repairing damage, and for disposing of excavation and surplus materials.
- (2) Payment does not include compensation for concrete placed outside the neat lines of the footing.

636.5.3 Steel Reinforcement

- (1) Payment for the Sign Supports Steel bid items is full compensation for providing all material complete in place.

SECTION 637 SIGNING

637.1 Description

- (1) This section describes furnishing and installing signs, of the type or types specified, on supports in place or erected under the contract.

637.2 Materials

637.2.1 Sign Base Materials

637.2.1.1 Aluminum Extrusions

- (1) Use the style of aluminum extrusions specified in the plans. The engineer will accept any shape reasonably close to the shape illustrated, with no interlocking arrangement, and conforming to the minimum weight requirements the plans specify. Use the same style and brand of extrusion required for all the work under the contract. Use aluminum extrusions conforming to ASTM B 221, alloy 6061-T6, 6063-T5, or 6063-T6.
- (2) Perform all shearing, cutting, punching, drilling, or other fabrication procedures on extruded panels before preparing the aluminum to receive reflective material.
- (3) The department will allow a maximum deviation from flat on the face of extrusions of 0.004 inches (0.10 mm) per one inch (25 mm) of extrusion width.
- (4) The engineer will not require sign edge molding.

637.2.1.2 High-Density Overlaid Plywood

- (1) Use base material conforming to the U.S. Product Standard PS 1 for construction and industrial plywood. Use material manufactured from a group 1 wood and conforming to the requirements for A-A or B-B high-density overlay exterior plywood intended for use in highway signs, and suitable for applying reflective sheeting to without further surface preparation other than as specified below in [637.3.2](#).
- (2) Make plywood sign panels from material not less than 5/8 inch (16 mm) thick, except that for signs with a face 2 feet by 2 feet (610 mm by 610 mm) or less with the horizontal dimension no greater than the vertical dimension, the contractor may use 1/2 inch (13 mm) thick material.

637.2.1.3 Sheet Aluminum

- (1) For this base material, use aluminum alloy 5052-H38 complying with ASTM B 209.
- (2) Ensure sign blanks are free from laminations, blisters, slivers, open seams, pits from heavy rolled-in scale, ragged edges, holes, turned-down corners, or other defects that might affect their appearance or intended use. Use blanks conforming to the Aluminum Association, Inc., requirements for commercial flatness and uniformity of thickness. Perform all shearing, cutting, and punching before coating and applying reflective or other surface material.
- (3) Ensure that the sheared edges of all sign blanks are straight and free from tears or raggedness. Round all corners unless the plans indicate otherwise. Ensure all punched or drilled holes are round; free from tears, raggedness, and distortion of the metal; and of the diameter and location shown on the department's Standard Layout of Sign Blank Detail, A 5-3.
- (4) Degrease, etch, and coat the sign blank on both sides with a chromate treatment conforming to ASTM B 449, class 2. Apply the coating to a mean thickness of 25 ton/ft² (270 mg/m²).
- (5) Furnish the following nominal material thickness or a thicker material for the indicated sign width:

WIDTH	NOMINAL THICKNESS
Under 20 inches (510 mm)	0.080 inch (2.0 mm)
20 to 36 inches, inclusive (510 - 890 mm)	0.100 inch (2.5 mm)
Over 36 inches (890 mm)	0.125 inch (3.2 mm)

637.2.2 Sign Face Materials

637.2.2.1 Standard Reflective Sheeting

- (1) Furnish standard reflective sheeting conforming to ASTM D 4956, type I, class 1 or 3 and having a durability as follows:
 - For orange and reboundable sheeting; 12 months.
 - For others; 24 months.

637.2.2.2 Type H Reflective Sheeting

- (1) Furnish type H reflective sheeting conforming to ASTM D 4956, type III, class 1 and having a durability as follows:
 - For orange and reboundable sheeting; 12 months.
 - For others; 36 months.

- (2) If the manufacturer provides a warranty for the type H sheeting, turn the warranty over to the department.

637.2.2.3 Type F Reflective Sheeting

- (1) Furnish type F prismatic reflective sheeting with a minimum initial coefficient of retroreflection as follows:

MINIMUM INITIAL COEFFICIENT OF RETROREFLECTION

in either cd/fc/ft² or cd/lx/m²

OBSERVATION ANGLE	ENTRANCE ANGLE	FLUORESCENT ORANGE	FLUORESCENT YELLOW	FLUORESCENT YELLOW/GREEN
0.2 deg	-4 deg	200	240	325
0.2 deg	+30 deg	92	150	205
0.5 deg	-4 deg	80	165	215
0.5 deg	+30 deg	50	75	110

- (2) Conform to the sheeting color chromaticity coordinates and luminance factors as follows:

SHEETING COLOR	CHROMATICITY COORDINATES								LUMINANCE FACTOR	
	1		2		3		4		MINIMUM	MAXIMUM
	X	Y	X	Y	X	Y	X	Y	Y	Y _F
Orange	0.562	0.350	0.645	0.355	0.570	0.429	0.506	0.404	20%	10%
Yellow	0.557	0.442	0.498	0.412	0.438	0.472	0.479	0.520	35%	15%
Yellow/green	0.387	0.610	0.368	0.539	0.421	0.486	0.460	0.540	50%	20%

- (3) The department may require independent verification of the initial coefficient of retroreflection and sheeting color.

637.2.2.4 Nonreflective Sheeting

- (1) Furnish nonreflective sheeting consisting of a flexible sign face material precoated with an adhesive and protected by a liner. Sheeting thickness, without the liner, shall be from 0.003 inches (0.07 mm) to 0.005 inches (0.13 mm) inclusive.
- (2) Provide test data showing that the sheeting has no appreciable shrinkage, discoloration, cracking, crazing, chalking, blistering, delamination, or loss of adhesion.

637.2.3 Sign Message Material

637.2.3.1 Demountable Route Markers

- (1) Provide demountable route markers for type I and type III signs fabricated in the shapes the plans show. For the base material, use aluminum at least 0.040 inch (1.0 mm) thick. Use a face material conforming to [637.2.2.2](#) and the route marker outline as the plans show. Stencil the numerals and letters with paste conforming to [637.2.3.4](#) below.

637.2.3.2 Type H Message Material

- (1) Unless the plans indicate otherwise, furnish and install demountable letters, numbers, symbols, and border for type I and type III signs fabricated from type H reflective sheeting on aluminum base material at least 0.040 inch (1.0 mm) thick.

637.2.3.3 Stencil Paste

- (1) Use a manufacturer-approved stencil paste for the type of face material applying it to.

637.2.3.4 Vandalism Sticker

- (1) Affix a vandalism sticker to the face of all type I, II, and III signs. The stickers are available at all department district offices.
- (2) Position the stickers on the signs according to the following procedures:
 1. Attach the sticker at the extreme lower left corner of all square or rectangular signs, horizontally and typically outside the sign border, or just inside the sign border if the space between the edge of the sign and the border is not sufficient to accommodate the sticker.
 2. On all signs of other shapes, for example stop, yield, and no passing zone pennants, place the sticker at the lowest edge or corner of the sign, parallel with the border or edge of the sign, and at the left corner or left side of the sign.
 3. On signs with a white border, place the sticker within the white border at the locations designated.

637.2.3.5 Sheeting Material Identification Code and Installation Date

- (1) On all type I, II, and III signs, stencil the sheeting material identification code and the installation date on the back of the sign.
- (2) The department assigns an alphabetical character to specific sheeting products, use this as the sheeting material identification code. Obtain the identification codes from the department's sign shop, located at:

3609 Pierstorff St.
Madison, WI 53704
- (3) For the installation date use the last 2 digits of the year the sign was installed, for example 01, 02, and so on. Stencil the numbers in 5/8-inch (16 mm) high characters on the sign back with stencil paste conforming to [637.2.3.4](#).
- (4) Stencil the identification code and date at the upper right corner of the sign back, placed so it is visible after mounting the sign on its supports.
- (5) A typical code and date reads F 02.
- (6) A sheeting code and date sticker, conforming to the shape established by the department's Sign Shop can be affixed to the back of the sign as an alternate method. The same requirements on the material identification code and installation date are still applicable.

637.2.4 Sign Mounting Hardware

637.2.4.1 Type I Signs

- (1) Connect individual aluminum extrusion panels together to form a completed sign assembly. For panel stitch hardware, use self-locking nuts, bolts, washers, and other hardware as follows:
 1. Stainless steel conforming to [513.2.2.5](#).
 2. Aluminum that the panel manufacturer either supplies or approves.
- (2) Mount the sign assembly using aluminum post clips, stainless steel bolts with self-locking nuts, and a protective stainless steel flat washer against each post clip. Provide the following:
 1. Stainless steel bolts, nuts, and washers conforming to [513.2.2.5](#).
 2. Aluminum post clips conforming to ASTM B 221, alloy 6061-T6, or ASTM B 108, alloy 356.0-T6.

637.2.4.2 Type II and III Signs

- (1) Mount type II and III signs using hex head nuts and bolts, washers, and other steel hardware treated in one of the following ways:
 1. Hot dipped or mechanically zinc coated according to ASTM A 153, class D.
 2. Cadmium plated according to ASTM B 766 type III, class 12.
 3. Electrically zinc coated according to ASTM B 633, type III, SC 3.
- (2) Use only nuts and bolts manufactured with sufficient clearance to allow the nuts to run freely on the bolts after plating or coating.

637.2.5 Color

- (1) For sign face and sign message materials provide the color the plans show.

637.3 Construction

637.3.1 Definitions

- (1) Type I signs consist of guide signs having extruded aluminum base material, reflective backgrounds, and reflective demountable messages. They are ground mounted on steel posts and are used in unlighted overhead locations.
- (2) Type II signs consist of miscellaneous warning, regulatory, informational, and standard size guide signs, having sheet aluminum or plywood base material, and reflective or non-reflective backgrounds, and non-removable messages.
- (3) Type III signs consist of small guide signs having sheet aluminum or plywood base material, reflective backgrounds, and reflective demountable messages. If ground mounted, type III signs have wooden post supports.

637.3.2 Manufacture and Assembly

637.3.2.1 General

- (1) Manufacture signs to conform to the dimensions and details the plans show. Letter series refer to the standard series approved by the FHWA. Ensure that the corners of type I signs are square, but make the borders as the plans show.
- (2) Where the department uses the term "message" in these specifications or on the plans, it includes letters, numerals, symbols, and borders.
- (3) Furnish shop drawings for review before fabricating type I, II, and III signs.

637.3.2.2 Preparing Sign Panels for Reflectorization

637.3.2.2.1 Aluminum Panels

- (1) If applying reflective sheeting to aluminum panels, prepare the panels as follows:
- (2) Perform the preliminary cleaning of the sign blanks by completely submerging them in a 3 percent solution of inhibited alkaline cleanser at 160 to 180 F (71 to 82 C) for 3 minutes, followed by a thorough rinse in clean running cold water. Instead of this method the contractor may use a grease solvent, such as naphtha, provided it applies the cleanser according to the manufacturer's directions.
- (3) After this preliminary cleaning, immerse the panels for at least 3 minutes in a 6 percent to 8 percent solution of phosphoric acid at 100 F (38 C). Then rinse the panels in a spray of cold water, followed by immersing for one minute in circulating hot water at 180 F (82 C). Dry the panels with forced warm air.
- (4) If using extrusions, and the panel length prohibits total immersion, then the contractor may apply 6 percent to 8 percent phosphoric acid at 100 F (38 C) to the surface by swabbing, brushing, or spraying, and allowing it to remain for 5 minutes, then remove the acid using a cold water rinse and dry with forced warm air.

637.3.2.2.2 High-Density Overlaid Plywood Panels

- (1) Ensure that the plywood blank surfaces are smooth, clean, and free from any oils, edge sealant, dust, or solvent. If the reflective sheeting manufacturer recommends, lightly sand the sign face surface then wipe with a solvent before applying the sheeting.

637.3.2.2.3 Handling Panels

- (1) If reflectorizing the surface of aluminum or plywood sign blanks, handle the surface with devices or clean canvas gloves between all cleaning and etching operations and when applying the reflective sheeting.

637.3.2.3 Applying Reflective Sheeting

- (1) Prepare sign panels and blanks as specified above and according to the reflective material manufacturer's recommendations. Apply reflective sheeting according to the manufacturer's recommendations.
- (2) After curing for 48 hours at 70 F (21 C), the bond between the reflective sheeting and the sign panel or blank must resist stripping from the panel with a stiff putty knife; and must withstand 8 hours of soaking in water at 75 F (24 C) without appreciable loss of adhesion.
- (3) Ensure that no line of separation exists between adjacent panels due to lack of reflective material. The contractor shall not extend the reflective sheeting from one panel to adjacent panels.

637.3.2.4 Applying Messages on Type II Signs

637.3.2.4.1 Signs with Black or Dark Message on a White, Yellow, or Orange Background

- (1) Apply the message to the signs by the silkscreen stencil process using a black or dark stencil paste the manufacturer of the face material approves for that application. The engineer will not accept message units cut from nonreflective sheeting and applied to the sign face.

637.3.2.4.2 Signs with White or Silver Message on a Red, Blue, Brown, or Green Background

- (1) Apply the message by individually cutting the borders, letters, numerals, and symbols from a white or silver sheet reflecting material and applying them to a background of colored sheet reflecting material according to the sheet reflecting material manufacturer's recommended procedure.
- (2) The contractor may also apply the message to the sign blank using the reverse screening process with a transparent stencil paste of the color specified in the special provisions, on a white or silver sheet reflecting background. If viewed in daylight or at night under normal vehicle headlights the sign must look uniform in color and the shade acceptable to the engineer. Use the brand of transparent paste that the reflective sheeting manufacturer recommends.

637.3.2.4.3 Signs with Yellow Message on a Brown Background

- (1) Apply the message to the sign blank using the reverse screening process with a non-transparent stencil paste of the color specified in the special provisions, on a yellow sheet reflecting background. If viewed in daylight or at night under normal vehicle headlights the sign must look uniform in color and the shade acceptable to the engineer. Use the brand of non-transparent paste that the reflective sheeting manufacturer recommends.
- (2) The contractor may also prepare signs by individually cutting the borders, letters, numerals and symbols from a yellow sheet reflecting material and applying them to the background of colored sheet non-reflecting material according to the sheet reflecting material manufacturer's recommended procedure.

637.3.2.5 Applying Clear Finish

- (1) If the reflecting material manufacturer recommends a clear finish, apply the finish to the face of the sign panel according to the manufacturer's instructions after applying the background reflectorization to type I and type III signs, and after applying the background and message for reflective type II signs and allowing them to dry completely.

637.3.2.6 Applying Demountable Copy

- (1) Fasten demountable copy to type I and type III sign panels with aluminum rivets or aluminum self-tapping screws. Place aluminum rivets or aluminum self tapping screws at the ends and at 90 degree corners of all demountable copy legend, borders, arrows, and route markers. Space rivets or self tapping screws at a maximum of 6 inches (150 mm) on center. Do not install rivets or self tapping screws within 1 inch (25 mm) of extruded aluminum panel joints.
- (2) Use full standard length border sections, except if necessary to use less to fit a sign dimension. Make cuts, if required, as close as possible to midway between reflecting units. Fit the border units snugly together so no gaps are visible.

637.3.2.7 Assembling Type I Signs

- (1) For type I signs use aluminum extrusion sign base material.
- (2) Assemble individual aluminum extrusions into signs the size the plans show, according to the extrusion fabricator's recommendations and in a manner the engineer approves.
- (3) Make each extension the full width of the sign without joint or splice.

637.3.2.8 Assembling Type II and Type III Signs

637.3.2.8.1 General

- (1) For type II and type III signs, use sheet aluminum or high-density overlay plywood sign base material of the size and shape the plans show.
- (2) The contractor shall not use horizontal joints on a type II or a type III sign with a vertical dimension of 48 inches (1220 mm) or less.

- (3) The contractor shall not use vertical joints on a type II or type III sign with a horizontal dimension of 144 inches (3660 mm) or less. The contractor shall not use more than one vertical joint on type II signs.

637.3.2.8.2 Battens Over Joints

- (1) If using 2 or more sheets of sign base material to make a single type II or type III sign, then attach a 6-inch (150 mm) batten of the same material as the sign base by screws or rivets to the back of the sign and covering the joint.
- (2) Use screws to attach battens to plywood signs. Drive the screws into the sign from the back and do not cut the face of the sign. For screws or rivets exposed on the face of metal signs, use flathead, countersunk, or screws or rivets machined otherwise to produce minimal projection. Cover the screws or rivets with reflective material the same color as the face of the sign at the point of exposure. Alternately, for battens on plywood signs the contractor may use one inch (25 mm) by 6-inch (150 mm) lumber, S4S, treated as specified for wood sign posts with any of the waterborne preservatives. Use battens that extend the full length of the joint, except stop horizontal battens within 10 inches (250 mm) of each sign post to allow mounting of the sign base material directly on the post, and stop vertical battens within 10 inches (250 mm) of all horizontal stiffeners or stringers to allow mounting the sign base material directly on them. Additionally, the contractor shall not use horizontal battens if locating a horizontal stiffener or stringer as specified below properly battens the joint.

637.3.2.8.3 Horizontal Stiffeners

- (1) Attach 2 horizontal stiffeners, made of 2 inch by 6 inch (50 mm by 150 mm) lumber, S4S, treated as specified for wood sign posts with any of the waterborne preservatives, by screws to the back of each type II or type III sign conforming to any of the following criteria:^[1]
1. Any sign having vertical joints between adjacent panels of sign base material.
 2. Any sign with plywood base material and a horizontal dimension exceeding 80 inches (2030 mm) and a vertical dimension less than 36 inches (915 mm).
 3. Any sign with aluminum base material and a horizontal dimension exceeding 80 inches (2030 mm) regardless of vertical dimension.

^[1] Exceptions to the listed criteria are:

1. Signs mounted on bridges and having continuous bearing on the bridge or on spacer blocks at both the top and the bottom of the sign.
 2. Signs mounted on horizontal stringers do not require additional stiffeners.
- (2) On plywood signs, drive the screws from the back of the sign and do not cut the face of the sign. For screws exposed on the face of metal signs use flathead, countersunk, or screws machined to produce a minimal projection. Cover the screws with reflective material the same color as the face of the sign at the point of exposure. Position the center of the stiffeners 9 inches (225 mm) above the bottom of the sign and 9 inches (225 mm) below the top of the sign, respectively. Except on signs having a vertical dimension of 27 inches (685 mm) or less, then center only one stiffener on the back of the sign. Ensure that stiffeners extend the full length of the sign.

637.3.2.8.4 Horizontal Stringers

- (1) Mount signs on one or more horizontal stringers if the plans show. Each stringer consists of 2-inch (51 mm) by 6-inch (150 mm) lumber, S4S, treated as specified for wood sign posts with any of the waterborne preservatives. Attach each stringer firmly to the back of the sign and the supporting wood sign posts with bolts or lag screws as specified above for fastening signs to supports. If the sign is mounted on one or more posts, then fasten the sign, each stringer, and each post at their respective points of intersection by one or more bolts or lag screws passing through or into all 3 parts of the assembly. Ensure that stringers extend from the outermost post on one side of the sign to the outermost post on the other side of the sign and bear directly against the back of the sign.

637.3.3 Installing Signs

637.3.3.1 General

- (1) If erecting signs before their message becomes applicable, cover the face of the signs, in a manner the engineer approves, to make their messages unreadable during both daytime and nighttime. Maintain the covering in good condition until the message becomes applicable and the engineer orders the covering removed or until the contract expires.

- (2) Use a covering material sufficiently durable to withstand the effects of weathering, but also not damaging the reflective face of the sign, during the expected length of time the covering is needed. The contractor shall not apply any tape to the sign face in order to fasten the covering material.
- (3) The contractor shall not install stop signs and yield signs before the time that they are applicable.

637.3.3.2 Placing and Orienting

- (1) The engineer will establish and stake, or mark on the pavement, the longitudinal location of each sign, including signs on the main line roadways, frontage roads, ramps, and intersecting roads.
- (2) Laterally position the sign from the shoulder edge or curb as the plans show, as noted in the special provisions, or as the engineer directs.
- (3) The proper elevation, offset, level, and orientation of all signs erected are the contractor's responsibility. Exercise care to preserve all stakes. Reset all stakes lost, damaged, displaced, or removed, at no expense to the department.
- (4) Generally, erect all signs so the edge and face of the sign are truly vertical and the face is normal to the centerline of the roadway that the sign serves, and so the sign faces slightly away from the motorists line of sight in order to avoid specular reflection and glare.

637.3.3.3 Fastening Signs to Supports

- (1) If the plans require the contractor to mount signs on utility poles or highway lighting poles installed by others, then follow the method of mounting the plans show.
- (2) Fasten type II and type III signs to wood sign posts with bolts or lag screws. For signs with Type H or Type F Reflective Sheeting, place a fiber, nylon, or clear plastic washer between the head of the bolt or screw and the face of the sign. For all signs, place a metal washer on the bolt beneath the nut.
- (3) Fasten signs to flanged beam sign supports and sign bridges according to the plans and the sign manufacturer's recommendations.

637.4 Measurement

- (1) The department will measure the Signs bid items by the square foot acceptably completed, measured as the area of sign face.

637.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
637.0100 -0199	Signs (type)	SF
637.0200 - 0299	Signs Reflective (type)	SF
637.0300 - 0399	Signs Non-Reflective (type)	SF

- (2) Payment for the Signs bid items is full compensation for providing all materials; for manufacturing and assembling the sign, including all messages; for hauling, handling, and installing the sign, including fasteners, necessary hardware, and vertical supports and U-bolts; and for replacing all stakes lost, damaged, displaced, or removed.
- (3) The department will pay for required sign supports, sign bridges, and electrical cable, under the appropriate bid item or items of the contract.

SECTION 638 STATE OWNED SIGNS AND SUPPORTS

638.1 Description

- (1) This section describes moving, removing, revising, or erecting state owned signs and supports.

638.2 Materials

- (1) Furnish materials conforming to the following:

Signing..... [section 637](#)

638.3 Construction

638.3.1 General

- (1) A sign is an installation at a single location that consists of several components or parts that together form one complete sign.
- (2) The contractor shall not display any signs before their message becomes applicable, cover them as required in [637.3.2.1](#).
- (3) Erect signs and supports at the new location as specified in [section 634](#) if using wood posts and as specified in sections 635, 636, and 637 if using steel supports.

638.3.2 Moving Signs

- (1) Under the Moving Signs bid items, remove existing signs, and transport and erect the signs at new locations. This work does not include moving structural steel supports, or moving or removing the footings.
- (2) Remove the signs without damaging them, and re-erect at the new location.
- (3) If moving any sign on wood posts, tubular steel posts, or flanged, steel channel supports, then also move the posts or supports, unless provided otherwise.
- (4) Remove all signs 25 square feet (2.3 m²) and larger from their supports before transporting. The contractor may transport smaller size signs attached to their supports, provided it uses methods that do not damage the sign.

638.3.3 Moving Sign Supports

- (1) Under the Moving Small Sign Supports bid item, remove existing wood supports; flanged, steel channel or other supports and transport to and erect these supports at new locations, and remove any resulting unused concrete footings.
- (2) Under the Moving Structural Steel Sign Supports bid item, remove existing structural steel supports and transport to, and erect the supports at new locations, and remove any resulting unused concrete footings.
- (3) Inspect the supports before moving and inform the engineer of any damage or deficiencies.

638.3.4 Removing Signs

- (1) Under the Removing Signs bid items, remove existing signs from their supports.
- (2) These signs become the contractor's property, unless specified otherwise in the plans or contract. The contractor shall satisfactorily dispose of these signs off the right-of-way.

638.3.5 Removing Small Sign Supports

- (1) Under the Removing Small Sign Supports bid item, remove wood supports, and flanged, steel channel or other supports.
- (2) These supports become the contractor's property, unless specified otherwise. The contractor shall satisfactorily dispose of these supports off the right-of-way. Remove unused concrete footings as specified for restoration of site in [638.3.9](#).

638.3.6 Removing Structural Steel Sign Supports

- (1) Under the Removing Structural Steel Sign Supports bid item, remove structural steel supports, and remove any resulting unused concrete footings.
- (2) Remove structural steel sign supports as specified for removing small sign supports in [638.3.5](#).

638.3.7 Revising Signs

- (1) Under the Revising Signs bid items, remove the message, partially, or totally as required, from signs in place, and install a revised message.
- (2) If the engineer directs, revise the message on designated type I or type III signs. Unless provided otherwise, make the revisions by using all new message units. If using new message units, conform to the requirements for message units on new signs of the same type, [section 637](#). Use new message units that are essentially similar in characteristics to the existing message units on each sign revised. Dispose of all removed message units in a satisfactory manner.
- (3) Schedule operations so a sign is out of service for the least time practical and, if possible, revise the message without removing the sign from its support.

638.3.8 Erecting State Owned Signs

- (1) Under the Erecting State-Owned Signs bid items, load state-furnished signs at a specified source, and transport and erect the signs at required locations.
- (2) Advise the engineer of the time proposing to load and haul the signs so the engineer has sufficient time to make them available.
- (3) Erect state-furnished signs as specified for erecting signs in sections 634 through 637.

638.3.9 Restoring the Site

- (1) Restore the site of any sign moved, removed, or erected, repair any damage to work caused by the contractor's operations, and dispose of any surplus excavation or materials. Remove all unused concrete footings resulting from the moving or removing of signs as specified for their removal in [204.3](#) and fill the resulting holes with earth or other suitable material as required, and restore the area to a condition similar to the adjacent area.

638.4 Measurement

- (1) The department will measure all the bid items under this section as each individual sign or sign support acceptably completed.

638.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
638.2100 - 2199	Moving Signs (type)	EACH
638.2600 - 2699	Removing Signs (type)	EACH
638.3000	Removing Small Sign Supports	EACH
638.3100	Removing Structural Steel Sign Supports	EACH
638.3200 - 3299	Revising Signs (type)	EACH
638.3600 - 3699	Erecting State-Owned Signs (type)	EACH
638.4000	Moving Small Sign Supports	EACH
638.4100	Moving Structural Steel Sign Supports	EACH

- (2) Payment for all the bid items under this section is full compensation for all the work required under the particular bid item; for providing message units as required; and for restoring the site. Payment does not include compensation for furnishing new wood posts, steel sign supports, and concrete footings, if required, the department will pay for these under the pertinent contract bid item, or as extra work if no bid item exists.

SECTION 639 DRILLING WELLS

639.1 Description

- (1) This section describes drilling vertical holes of specified sizes in earth formation or rock formation, or both to the required depth; inserting casing pipe; placing liner pipe, if required; sealing casing with grout; placing pump, screen, and well platform; constructing well shelter; and test pumping.

639.2 Materials

639.2.1 General

- (1) Furnish grade A, A-FA, A-S, A-T, A-IS, or A-IP concrete conforming to [501.2](#).
- (2) For grout use fine aggregate conforming to [501.2.5.3](#) and type I, IS, I(SM) or IP portland cement.
- (3) Furnish lumber and timber conforming to [507.2.2](#).

639.2.2 Well Casing Pipe

639.2.2.1 Upper Drillhole

- (1) If using 8, 10, or 12 inch (200, 250, or 300 mm) size pipe temporarily in constructing the upper drillhole, use pipe of sufficient strength and weight to structurally withstand all driving operations. Use welded or threaded coupling joints with this pipe.

639.2.2.2 Lower Drillhole

- (1) For casing the lower drillhole, use new steel casing pipe. Use pipe conforming to NR 812.17.

639.2.3 Liner Pipe

- (1) For liner pipe use new steel pipe of sufficient strength and weight to structurally withstand all driving operations. On this pipe, use welded joints and fit with standard type driving shoes. Use the length and diameter of liner pipe the engineer directs.

639.2.4 Pump

- (1) Use a hand-operated metal drinking fountain type pump with a mounting base that accepts the casing pipe specified and conforms to the plan details. For the drop pipe use new zinc coated standard steel with a 1 1/4 inch (32 mm) inside diameter, unless the plans specify otherwise. Use a 7/16-inch (11 mm) diameter steel pump rod having 14 standard threads per one inch (25 mm). For depths to the static water surface of 150 feet (46 m) or less, use a cylinder with a 2-inch (50 mm) inside diameter, and for depths exceeding 150 feet (46 m), use a cylinder with a 1 11/16 inch (43 mm) inside diameter.
- (2) Provide cast iron floor drains conforming to the size and details the plans show.

639.2.5 Well Screen

- (1) Provide a stainless steel screen of the specified diameter and conforming to NR 812.13 requirements.

639.3 Construction

639.3.1 Code, Permit, and Registration Requirements

- (1) Perform all work connected with drilling, driving, and outfitting a well according to NR 812, Well Construction and Pump Installation, Wisconsin Administrative Code of the WDNR, Division of Environmental Analysis and Review.
- (2) The contractor shall obtain all permits, licenses, or other requirements needed to prosecute the work at its own cost and expense. Provide all notices, pay all fees, and comply with all laws, ordinances, codes, and regulations bearing on the conduct of the work.
- (3) Employ an engineer-approved well driller registered with the WDNR division of environmental analysis and review before starting drilling operations. The well driller shall produce satisfactory evidence of experience, capability, and equipment before performing any work.
- (4) Use a pump installer registered with the WDNR division of environmental analysis and review to install the pump.

639.3.2 Geologic Formation

- (1) The contractor shall save and deliver a sample of material taken from each 5 feet (1.5 m) of drilling and at every change in formation, to the Wisconsin Geological and Natural History Survey. The contractor shall also keep an accurate record of the top and bottom of each layer of all formations penetrated.
- (2) Provide daily written reports to the engineer beginning when the drilling equipment is erected and ending when the drilling equipment is removed. Include the following:
 1. The nature of the materials encountered during drilling.
 2. The work done during each day, including depth drilled, casing set, and water tests.
 3. The depth-to-water level in the well at the beginning and end of each shift.
 4. Any other pertinent data the engineer may request for the record.
- (3) Immediately advise the engineer of any circumstances that might alter well construction, or have any effect in determining if the drilling operations should change. If the contractor fails to keep the engineer informed, this may result in non-payment for items of work performed.
- (4) Take the above-specified material samples every 5 feet (1.5 m) and at each change in formation according to Wisconsin Geological and Natural History Survey instructions.
- (5) After completing a job sample, pack it in a box or bag, and mail or ship it express collect to the following address:

Wisconsin Geological and Natural History Survey
3817 Mineral Point Road
Madison, Wisconsin, 53705-5100

- (6) The contractor may obtain sample bags and tags at no cost by writing to the same address. Send the driller's log of the well at the same time. The driller's log shall include, in addition to a record of material encountered:
 1. Data on size or sizes of hole.
 2. Length and size of casing, including liner and screen.
 3. Water level.
 4. Results of pumping tests.

639.3.3 Water Sampling and Testing

- (1) Immediately after completing the well, collect water samples in conformance with the procedure stated in NR 812.22 and submit the samples in bottles furnished by the laboratory for bacteriological and nitrate analysis, and for iron and manganese, turbidity and hardness determination to:

State Laboratory of Hygiene
465 Henry Mall
Madison, Wisconsin, 53706

- (2) The contractor shall indicate in the remarks section of the data sheet accompanying the sample bottles that a copy of the report be forwarded to the engineer on the project and sent to the:

State Department of Natural Resources
Environmental Analysis and Review
101 South Webster Street
PO Box 7921
Madison, Wisconsin, 53703

639.3.4 Precautions to Take

- (1) Take precautions to prevent contaminated or polluted water, or other pollutants such as gasoline from entering the drill hole during construction of the well and following completion.
- (2) If the well becomes contaminated or polluted during construction or upon completion, due to contractor neglect, at no cost to the department, perform all work or supply all casings, seals, sterilizing agents or other materials necessary to eliminate the contamination or pollution.
- (3) Exercise extreme care in performing the work to prevent caving in or breaking down the strata overlying the one that is producing the water. Obtain the engineer's approval of the contractor's method of developing, pumping, or bailing the well, until producing water substantially free of silt or sand, and until the turbidity is less than 5 on the silica scale described in Standard Methods of Water Analysis. Upon completing the well, provide and secure a screwed, flanged, or welded cap to the top of the well casing.

- (4) Between placing the protective well casing and grouting the well, seal the annular space between the inner casing and the larger outer casing with a temporary plug to prevent the entry of foreign material.
- (5) If the contractor fails to construct the well to the depth specified, or the depth the engineer orders, or if the well is abandoned because of loss of tools or from any other cause, for example, poor well alignment, construct another well at an adjacent engineer-approved location. Fill the abandoned hole with concrete as specified for abandoning pipes and structures in [204.3.3](#).
- (6) Take the necessary precautions to protect all trees and structures at the site from damage by and during the operations.

639.3.5 Drilling Well Holes

- (1) Ensure that holes drilled through earth formations are the required size, and extend from the ground surface to underlying rock formation, or to the depth the engineer directs. Drill each hole with a fully dressed bit the proper size to accommodate driving the corresponding well casing pipe concurrently with drilling operations. If drilling holes through rock formation use a fully dressed bit, the proper size to produce the required drilled hole size.
- (2) If the driller considers it necessary to blast in the drill hole, if drilling through formations containing boulders, discuss the problem with the engineer before any shooting or blasting. Perform all blasting work using a licensed blaster.
- (3) Furnish potable water for all drilling operations.

639.3.6 Alignment

- (1) Align the well so that the pump proper and its accessories function and operate free of any trouble that might occur from a misaligned well casing. Drill the well so that the center line does not deviate from a straight line more than the following amounts per 100 feet (30 m) of pump setting depth, plus 25 percent: for a 4 inch (100 mm) well, 4 inches (100 mm); for a 6 inch (150 mm) or larger well, 6 inches (150 mm).
- (2) If the engineer judges the well alignment unsatisfactory at any time, because of a condition in excess of that above, then correct the condition before proceeding with the drilling. If the hole is misaligned and correction is not possible or practical, drill a new hole.
- (3) During well construction, furnish the labor, tools, and equipment required for making alignment tests, and make these tests when the engineer directs.

639.3.7 Well Casing

- (1) Ensure that the well casing when in place is watertight from top to bottom. If driving into unconsolidated material or through it to a seat in rock, as opposed to setting in place in a larger drilled hole, fit the casing with an engineer-approved standard driving shoe. During grouting operations, remove the outer temporary casing used to construct the upper drill hole unless the engineer allows otherwise.

639.3.8 Well Screen

- (1) Fit the lower end of the well casing pipe, if specified, with the required well screen. Install the well screen in a manner that allows removing the screen later.
- (2) Submit a selected sample of the water bearing formation to be developed, to the screen manufacturer for mechanical analysis and its recommendation of a size of screen slot openings and length of screen necessary to allow the well to produce the required yield capacity. The contractor shall not use a screen less than 3 feet (900 mm) long, unless the engineer approves. Furnish a copy of the manufacturer's report or recommendation to the engineer.

639.3.9 Liner Pipe

- (1) If a caving formation occurs in drilling in rock, seal it by driving a liner pipe fitted with a driving shoe into the rock to at least 10 feet (3 m) above the caving zone. Then extend a drill hole, the same diameter as the liner pipe, below the liner pipe to the depth necessary to produce the required quantity of water.

639.3.10 Grouting

- (1) Mix a neat cement grout by methods, and to a consistency, the engineer approves, using not more than 5 1/2 gallons (21 L) of clean water per sack (42.6 kg) of cement. The contractor shall not use admixtures in the cement grout.

- (2) Place this grout in the annular space between the inner well casing and the outer casing, or the casing and the hole where the casing does not extend the entire depth of the hole. If using a liner pipe, then fill the annular space between the liner and the casing to the top of the liner pipe.
- (3) Place the grout by using a pressure method the engineer approves, with a pump designed for the purpose, forcing the grout from the bottom upward toward the surface. Continuously place this grout until the annular spaces are filled.
- (4) Provide standby grout placing equipment in case the original equipment fails. Use standby equipment that provides gravity placement of grout with a pipe or tremie in the annular space between the casings.
- (5) With the engineer's approval, and if applying through a conductor pipe that extends to the placement point, the contractor may use concrete grout, consisting of cement, sand, and water in a proportion of one sack (42.6 kg) cement, to an equal volume of dry sand, and 5 1/2 gallons (21 L) of water, instead of neat cement.

639.3.11 Test Pumping

- (1) Upon reaching a water bearing formation that appears capable of producing the desired yield, the engineer may direct conducting pumping tests to determine if the water supply is satisfactory, and to establish the well depth
- (2) Provide a pump capable of pumping the specified gallons (L) per minute to the discharge point against a free discharge and capable of continuous operation for the specified test period. Make provisions for throttling the pumping rate in order to determine water level data at various pumping rates.
- (3) Furnish suitable and adequate equipment for making volumetric measurements of water pumping rates. Furnish electric probes or other engineer-approved means to measure static and dynamic water levels to the nearest 1/10 of a foot (25 mm).
- (4) Before conducting a pumping test, clear the well of all cuttings and determine the well depth and static water level.
- (5) Begin test pumping at a low rate and gradually increase it in a manner that allows measuring the dynamic water level at various discharge increments. Take measurements of the dynamic water level at discharge increments the engineer specifies. At each increment, hold the pumping rate constant during measurement of the water level and rate of discharge.
- (6) Maintain the specified pumping rate for the specified test period to determine if the well conforms to contract provisions.
- (7) If the engineer deems the well adequate, make measurements of the dynamic water level at higher discharge rates as the engineer designates.
- (8) If at any point during the test pumping the engineer determines the water supply is inadequate, discontinue test pumping, and the engineer will deem a unit of test pumping complete. The engineer will direct any further drilling and subsequent test pumping.
- (9) Transport all water pumped from a well during a test period or at any time during the contractor's operations to a place where it causes no damage.

639.3.12 Pump and Well Platform

- (1) Construct the concrete platform at the prepared well site as the plans show. Mount the pump on the well casing according to plan details.

639.3.13 Wayside Well Shelter

- (1) Construct the wayside well shelter with the materials and as the plans show.

639.3.14 Cleaning Up Operations

- (1) Upon completing well drilling operations and placing all materials for the well, pump, and related facilities; clean the well by bailing to remove all cuttings from the drill hole; clear the site of all debris, excess materials and equipment; and perform any necessary ground leveling work, so the site appears neat and the project finished in all respects.
- (2) Disinfect the well as required by the Wisconsin Well Construction and Pump Installation Code NR 812.41.

639.4 Measurement

639.4.1 Drilled Holes

- (1) The department will measure the Drill Hole in Earth and Drill Hole in Rock bid items by the linear foot of vertical depth of hole acceptably completed.

639.4.2 Well Casing Pipe

- (1) The department will measure the Well Casing Pipe bid items by the linear foot acceptably completed. The department will measure the casing pipe for the lower drill hole from the upper cutoff point to the bottom of the driving shoe. The department will not measure the outer temporary casing used to construct the upper drill hole for payment.

639.4.3 Well Screen

- (1) The department will measure Well Screen by the linear foot acceptably completed, from the bottom of the driving shoe to the lower end of the screen.

639.4.4 Grout for Sealing Well Casing

- (1) The department will measure Grout for Sealing Well Casing by the cubic foot acceptably completed.

639.4.5 Pump and Well Platform

- (1) The department will measure Pump and Well Platform as each individual unit acceptably completed.

639.4.6 Wayside Well Shelter

- (1) The department will measure Wayside Well Shelter as each individual shelter acceptably completed.

639.4.7 Test Pumping

- (1) The department will measure Test Pumping, performed at the engineer's direction, as each individual unit acceptably completed. The depth of the well, as the engineer determines, whether shallower or deeper, will not constitute basis for the contractor to claim additional compensation above the unit prices shown in the contract for the pertinent contract items.

639.5 Payment

639.5.1 General

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
639.0100 - 0199	Drill Hole in Earth (inch)	LF
639.0500 - 0599	Drill Hole in Rock (inch)	LF
639.1000 - 1099	Well Casing Pipe (inch)	LF
639.1700	Well Screen	LF
639.2100	Grout for Sealing Well Casing	CF
639.2500	Pump and Well Platform	EACH
639.3000	Wayside Well Shelter	EACH
639.4000	Test Pumping	EACH

639.5.2 Drilled Holes

- (1) Payment for the Drill Hole in Earth and Drill Hole in Rock bid items is full compensation for providing all materials required for drilling, including temporary casing pipe for upper drill hole; for providing all water necessary for drilling holes; for drilling, blasting, alignment, and making alignment tests; for removing temporary casing; for procuring licenses and permits; for collecting and delivering samples of drilling to the Wisconsin Geological and Natural History Society; for collecting and delivering water samples to the State Laboratory of Hygiene; for disposing of all excavated material; and for record keeping and reporting.
- (2) If the contractor fails to construct the well to the depth specified, or the depth the engineer orders, or if the well is abandoned because of loss of tools, or from any other cause such as poor well alignment, and the engineer directs the contractor to drill in another location the department will not make further payment until the new well progresses to the point in construction beyond that which the previous well was abandoned, only then will the department make payment as provided here. The department will not make additional compensation for filling the abandoned hole with concrete, according to the requirements for abandoning wells and structures specified in [204.3.3](#). The department will include all costs of materials, labor, and equipment involved in blasting or shooting operations in the price bid for other items, and will not make payment for work done and materials used in the abandoned hole.

639.5.3 Well Casing Pipe

- (1) Payment for the Well Casing Pipe bid items is full compensation for providing all materials, including pipe and driving shoes; for handling, hauling, welding, driving, placing, and cutting off casing; for disinfecting the well; and for disposing of surplus materials, including pumped water.
- (2) The department will pay for furnishing and installing the liner pipe as extra work.

639.5.4 Well Screen

- (1) Payment for Well Screen is full compensation for providing all materials; and for handling, hauling, and installing screen.

639.5.5 Grout for Sealing Well Casing

- (1) Payment for Grout for Sealing Well Casing is full compensation for providing all materials; and for mixing and placing grout.

639.5.6 Pump and Well Platform

- (1) Payment for Pump and Well Platform is full compensation for providing all materials; for providing material for and grading mound at well site; for placing and finishing concrete; for installing pump, fittings, and fixtures; and for cleaning up the well site and disposing of debris and surplus materials.

639.5.7 Wayside Well Shelter

- (1) Payment for Wayside Well Shelter is full compensation for providing and erecting all materials; for all excavating and backfilling; and for cleaning up the site and removing debris and surplus material.

639.5.8 Test Pumping

- (1) Payment for Test Pumping is full compensation for providing all materials and for all labor, tools, equipment, and incidentals.
- (2) The department will include all costs of obtaining, preserving, and transmitting geologic, water samples, and records including materials, labor, equipment, transportation, and incidentals in the unit prices for bid items.
- (3) The cost of clean-up operations, including site restoration, is included in the unit prices for bid items.
- (4) The department will not pay for contract time while awaiting test results on required water samples unless other contract operations are in progress in the same time.

SECTION 641 SIGN BRIDGES AND SUPPORTS

641.1 Description

- (1) This section describes providing, erecting, and repairing sign bridges and sign supports.

641.2 Materials

641.2.1 General

- (1) Unless specified otherwise, the contractor may furnish either aluminum sign bridges, or zinc coated steel sign bridges.

641.2.2 Steel Bolts

- (1) Provide high strength bolts, nuts, and washers conforming to AASHTO M 164, Type 1 and are mechanically zinc coated according to AASHTO M 298. Ensure that zinc coated nuts are tapped oversize according to ASTM A 563 and conform to Supplementary Requirement S1 of ASTM A 563.
- (2) Provide anchor bolts conforming to AASHTO M 314, grade 55 and Supplementary Specification S1, or ASTM A 449 as the plans show, with the following additional requirements:
 - Use cut bolt threads, except for threads on bolts conforming to ASTM 314, grade 55, form these threads by rolling.
 - Use bolts conforming to a longitudinal Charpy V-Notch test of 15ft-lb (20.4 Nm) at 40 F (5 C).
- (3) On the threaded end of anchor bolts, nuts, and washers, hot-dip zinc coat the portion the plans show according to AASHTO M 232, or mechanically zinc coat according to AASHTO M 298.
- (4) Use only nuts and anchor bolts manufactured with sufficient clearance to allow the nuts to run freely on the bolts after coating. Apply a good grade of heavy grease to the bolt threads of anchor bolts before applying the nuts.

641.2.3 Grating

- (1) Provide walkway grating conforming to the plans.

641.2.4 Pipe

- (1) Provide pipe for handrail conforming to ASTM B 241 alloy 6063-T6.

641.2.5 Steel Chain

- (1) Provide zinc coated carbon steel chain of the size, type, and length the plans show and include all accessories the plans show.

641.2.6 Certification

- (1) Present a certified report of test or analysis to the engineer for the castings, columns, truss members, pipes, anchor bolts, and structural sections. The engineer must approve the material before the contractor may install in the work.
- (2) The engineer may retest materials delivered to the job site; furnish the specimens for this testing at no expense to the department.

641.2.7 Aluminum Sign Bridges

641.2.7.1 Columns, Crossarms, Truss Chords, and Braces

- (1) Provide columns, crossarms, truss chords, and braces made of extruded aluminum tubing conforming to ASTM B 221, alloy 6061-T6. Ensure the tubing is free from discoloration, nicks, and blemishes resulting from improper packing and handling.

641.2.7.2 Aluminum Plates

- (1) Provide plates and sheets conforming to ASTM B 209, alloy 6061-T6.

641.2.7.3 Aluminum Structural Shapes

- (1) The contractor may use rolled or extruded standard structural shapes conforming to ASTM B 308, alloy 6061-T6.

641.2.7.4 Aluminum Washers

- (1) Provide washers conforming to ASTM B 209, alloy 2024-T4. For aluminum spring lock washers, conform to ASTM B 211, alloy 7075-T6.

641.2.7.5 Aluminum Shims

- (1) Provide shims conforming to ASTM B 209, alloy 1100-0.

641.2.7.6 Castings

- (1) Provide material for post bases conforming to ASTM B 26, alloy 356-T6. Furnish splicing flange material, if cast, conforming to ASTM B 26, alloy 356-T7. Provide material for post caps, if cast, conforming to ASTM B 26, alloy 356-F.

641.2.7.7 Welding Material

- (1) Provide bare wire electrodes for use with the gas metal-arc process, and welding rods for use with the gas tungsten-arc process conforming to AWS A 5.10 for aluminum and aluminum-alloy bare welding rods and electrodes.
- (2) Provide tungsten electrodes for the gas tungsten-arc process conforming to AWS A 5.12 for tungsten arc-welding electrodes.
- (3) Provide the filler metals shown with the particular base metals in the following table. The engineer may approve the use of other filler metals.

BASE METAL	FILLER METAL
3003 to 3003.....	ER1100
3004 to 3004.....	ER4043
5052 to 5052.....	ER5356 ^[1]
5083 to 5083.....	ER5183
5086 to 5086.....	ER5356 ^[1]
5456 to 5456.....	ER5556
6061 to 6061.....	ER5356 ^[1]
6063 to 6063.....	ER5356 ^[1]
356.0 to 6061.....	ER4043
356.0 to 6063.....	ER4043

^[1] The contractor may use ER5183, ER5356, and ER5556 interchangeably for these base metals.

- (4) Cover and store filler metals in a dry place at uniform temperatures. The contractor shall not open original rod or wire containers until used. Ensure that rods and wire are free of moisture, lubricant, or other contaminants. If leaving spools of wire temporarily unused on the welding machine, keep them covered to avoid contamination. If leaving a wire spool unused for more than a short length of time, return it to the carton and tightly reseal.

641.2.7.8 Stainless Steel Bolts and Nuts

- (1) Provide stainless steel set screws, bolts, nuts, and washers, for base plate clamps, tower connections, and U bolts as specified for bolts and nuts in [513.2.2.5](#).

641.2.8 Steel Sign Bridges

- (1) Furnish materials conforming to the following:
Structural Steel and Miscellaneous Metals[506.2](#)
- (2) If using steel pipe for chords and columns for sign bridges, conform to the American Petroleum Institute's Specification for Line Pipe API-5L and the grade the plans show. For all other pipe used for sign bridges, conform to ASTM A 53, grade B of type E or S. If using structural steel for columns and in trusses for sign bridges, conform to ASTM A 709 grade 36.
- (3) Furnish sign bridge trusses, columns, and steel accessories that are zinc coated according to ASTM A 123, the zinc coating must withstand 8 one-minute dips in the Preece test solution, ASTM A 239.

641.2.9 Overhead Sign Supports

- (1) Provide commercially fabricated overhead sign supports conforming to AASHTO design and fabrication standards for structural supports for highway signs, luminaires, and traffic signals. Use a design life of 50 years with a wind importance factor of 1.00. Design to withstand a 3 second gust wind speed of 90 mph (145 km/h). Do not use the methods of appendix C of those AASHTO standards.
- (2) Design structures, listed as applicable structure types in the AASHTO standards, to the fatigue category criteria as follows:
 1. Structures carrying variable message signs:
 - Category I criteria for structures over all roadway types.
 2. Structures carrying type 2 signs:
 - Category II criteria for structures over highways and free flow ramps.
 - Category III criteria for structures over local roads and city streets.
- (3) Use the posted speed limit of the roadway beneath the structure for truck-induced gusts.
- (4) Submit shop drawings identified by structure number, design computations, and material specifications to the engineer before erecting sign supports. Have a registered professional engineer sign, seal, and date those drawings and certify that the design conforms to AASHTO standards and the contract. Submit an additional signed, sealed, and dated shop drawing identified by structure number, to the development section of the department's bureau of structures.
- (5) Provide steel pole shafts and mast arms that are zinc coated according to ASTM A 123. Provide bolts and other hardware conforming to [641.2.2](#).
- (6) Provide concrete sign support bases conforming to [636.2](#) and constructed as the plan details show. If the plan does not show design details for the sign support base, design the base and construct as that design specifies.
- (7) For contractor-designed bases, include the following as a part of the sign support shop drawings:
 1. Base size and configuration.
 2. Reinforcing steel size and layout.
 3. Elevations of the top of each concrete base pad.
 4. Elevation of the roadway high point immediately under the sign.
- (8) Also, for contractor-designed bases, specify the following in the sign support shop drawings:
 1. Concrete base pads protrude 2 inches (50 mm) or less above ground level.
 2. Concrete compressive strength is 3500 pounds per square inch (24 MPa) or more.
 3. Reinforcing steel conforms to AASHTO M 31 for grade 60 (420).
 4. Anchor bolts conform to AASHTO M 314 for grade 55.

641.3 Construction

641.3.1 General

- (1) Use construction methods for this work, including fabrication, inspection, erection, mill test reports, and shop drawings, conforming to [section 506](#), and as specified otherwise below.
- (2) Fabricate sign bridges conforming to the dimensions, span length, and details the plans show.
- (3) Furnish anchor bolts and erection bolts, as required according to the plans, with each sign bridge.
- (4) The contractor shall not erect columns for the sign bridge until the concrete footings cure for at least 7 days.

641.3.2 Aluminum Sign Bridges

- (1) Under the Sign Bridge Single Pole Sign Support One Sign bid items, furnish and erect single pole sign supports with attachments for signs facing in one direction.
- (2) Under the Sign Bridge Single Pole Sign Support Two Signs bid items, furnish and erect single pole sign supports with attachments for signs facing in opposite directions.

- (3) Under the Sign Bridge Cantilevered bid items, furnish and erect cantilevered sign bridges with a single supporting structure.
- (4) Under the Sign Bridge Structure Mounted bid items, furnish and erect sign bridges mounted on overhead roadway bridges.
- (5) Under the Sign Bridge bid items, furnish and erect sign bridges with multiple supporting structures.

641.3.2.1 Fabrication

- (1) Fabricate according to the Aluminum Association's specifications for aluminum structures.

641.3.2.2 Bending

- (1) The engineer will allow bending only for plates used for hand holes, as the plans show.

641.3.2.3 Welding

641.3.2.3.1 General

- (1) Weld joints as the plans show and as provided below.
- (2) The welding terms used in these specifications are defined in AWS Welding Terms and Definitions (AWS A 3.0) of the American Welding Society.
- (3) For welding symbols on plans, use those shown in Symbols for Welding and Nondestructive Testing of the American Welding Society. Use added notes or details to fully explain special conditions.
- (4) Weld aluminum alloys using the gas metal-arc or the gas tungsten-arc process. The contractor may use other processes, with the engineer's approval. Use material for permanent backing that is at least equivalent in weldability to the base metal being welded.

641.3.2.3.2 Shielding Gases

- (1) For shielding gases, use welding grade or better. For gas metal-arc welding use argon, helium, or a mixture of the 2 (approximately 75 percent helium and 25 percent argon). For gas tungsten-arc welding done with alternating current, use argon. For gas tungsten-arc welding done with direct current, straight-polarity, use helium. Use hoses made of synthetic rubber or plastic. The engineer will not allow use of natural rubber hose. The engineer will not allow hose used previously for acetylene or other gases.

641.3.2.3.3 Preparing the Materials

- (1) Make joint details according to design requirements and detail drawings. The contractor shall not change the locations of joints without the engineer's approval.
- (2) Perform edge preparation by sawing, machining, clipping, or shearing, except mill the ends of tubular members to a close fit, making the opening a maximum of not more than 1/16 inch (1.6 mm.) The contractor may use gas tungsten-arc, or gas metal-arc cutting. Ensure that cut surfaces conform to the ANSI surface roughness rating value of 250. The engineer will not allow oxygen cutting.
- (3) Ensure that surfaces and edges being welded are free from fins, tears, and other defects that would adversely affect the weld quality.
- (4) Remove dirt, grease, forming or machining lubricants, or any organic materials from the areas being welded by cleaning with a suitable solvent, or by vapor degreasing.
- (5) Deoxidize all edges and surfaces being welded by a process acceptable to the engineer. If using wire brushing, use stainless steel brushes. The contractor shall not use hand power-driven wire brushes that were used on other materials, on aluminum. If mechanical methods of oxide removal are inadequate, use a standard chemical method. Perform welding within 24 hours after chemical treatment. If using gas tungsten-arc welding with direct current, straight-polarity, then remove the oxide from all edges and surfaces being welded by a standard chemical method.
- (6) The contractor shall not weld anodically treated aluminum unless it removes the condition from the joint area being welded.

641.3.2.3.4 Welding Procedure

- (1) For butt welds that require 100 percent penetration, except those produced with the aid of backing, chip or machine out the root of the initial weld to sound metal before beginning welding from the second side. If making butt welds with backing, completely fuse the weld metal with the backing. If accessible, remove the backing for welds subject to computed stress, or exposed to view on the completed structure and are not otherwise a part of the structure, and grind or machine the joints smooth. In tubular members, make butt welds that are subject to computed stresses using permanent backing rings or strips.

- (2) Use the same procedure for production welding of any particular joint, as used in the procedure qualification for that joint.
- (3) Protect all welding operations, either shop or field, from air currents or drafts to prevent any loss of gas shielding during welding. Provide adequate gas shielding to protect the molten metal during solidification.
- (4) Whenever practical, position the work for flat position welding.
- (5) In both shop and field, ensure all weld joints are dry at time of welding.
- (6) Use suitable: sized electrode, voltage and amperage, welding speed, gas or gas mixture, and gas flow rate for the thickness of the material, design of joint, welding position, and other circumstances present in the work.
- (7) Perform gas metal-arc welding with direct current, reverse-polarity. Perform gas tungsten-arc welding with alternating current, or with direct current, straight-polarity.
- (8) If the joint being welded requires specific root penetration, make a sample joint and a macroetched cross-section of the weld to demonstrate that the joint welding procedure being used will attain the required root penetration. Make the sample joint at least one foot (300 mm) long, and weld with the electrode, polarity, amperage, voltage, speed, gas mixture, and gas flow rate proposing to use in production welding. The engineer may accept evidence on record instead of the preceding test.
- (9) If preheat is needed, the contractor shall not exceed 350 F (176 C) for heat-treated alloys and 600 F (315 C) for non-heat-treated alloys. Measure the temperature by temperature indicating crayons, or by pyrometric equipment. The contractor shall not hold heat-treated alloys at the maximum preheat temperature, or at temperatures near the maximum, for more than 30 minutes.

641.3.2.3.5 Weld Quality

- (1) Regardless of the method of inspection, the engineer will accept or reject welds based on the following conditions:
 1. The engineer will not accept cracks in welds or the adjacent base metal.
 2. The engineer will not accept copper and slag inclusions.
 3. The engineer will not accept porosity in excess of that allowed by appendix H of the ANSI/AWS D1.2 Structural Welding Code-Aluminum.
 4. The engineer may accept lack of fusion, incomplete penetration, or tungsten or oxide inclusions only if small and well dispersed.
 5. The engineer will not accept an undercut more than 1/64 inch (0.40 mm) deep if its direction is transverse to the primary stress in the undercut part. The engineer will not accept an undercut more than 1/32 inch (0.8 mm) deep if its direction is parallel to the primary stress in the undercut part.
 6. The engineer will not accept any overlap.
 7. Fill all craters to the full cross section of the welds.
- (2) The engineer will reject welds with defects greater than the levels of acceptance specified above, unless corrected according to [641.3.2.3.7](#).

641.3.2.3.6 Inspection

- (1) To determine compliance with [641.3.2.3.5](#), visually inspect all welds; additionally, the engineer may subject all butt welds in main, stress-carrying members of highway sign bridges that are subject to tension or stress reversal, as the engineer determines, to radiographic or ultrasonic testing over the entire length of the weld. For highway sign structures, inspect by the dye penetrant method on fillet welds connecting columns to bases and main chord members, including the associated flanges, gussets, or main load carrying brackets or members, and on fillet welds connecting flanges to the main truss chord members. Perform the dye penetrant tests according to ASTM E 165, method B, procedures B-2 or B-3. Furnish all materials, equipment, and personnel to perform this inspection.

641.3.2.3.7 Corrections

- (1) Instead of rejecting an entire piece or member containing welding that is unacceptable, the engineer may allow the following corrective measures, whose approval is required before making each repair.
- (2) Correct defective welds by removing and replacing the entire weld, or as follows:

1. For cracks in welds or base metal: Determine full extent of crack by dye penetrant method or other positive means. Remove crack throughout its length and depth, and reweld.
 2. For excessive porosity, lack of fusion: Remove defective portions and reweld.
 3. For copper or tungsten inclusions: Remove defective portions and reweld.
 4. For excessive concavity or crater, undercut, undersize welds: Clean and deposit additional weld metal.
 5. Overlap: Reduce by removing excess weld metal.
- (3) Remove the defective areas by chipping or machining. The contractor shall not use oxygen cutting. Before rewelding, the engineer will inspect the joint to ensure removal of the entire defective weld. If using dye penetrant to inspect the weld, remove all traces of penetrant solutions with solvent, water, heat, or other suitable means before rewelding.

641.3.2.3.8 Qualifying Procedures, for Welders and Welding Operators

- (1) Before performing joint welding procedures, pre-qualify the procedure using methods specified in ANSI/AWS D1.2, AWS Structural Welding Code-Aluminum at no expense to the department. The engineer may accept evidence of previous qualification of the joint welding procedures being used.
- (2) Hire only welders and welding operators to perform work under these specifications that were qualified previously by tests specified in ANSI/AWS D1.2, AWS Structural Welding Code-Aluminum. The engineer may accept evidence of previous qualification of the welders and welding operators the contractor employs. Use the same process and type of equipment required to execute work, to qualify the welders and welding operators.

641.3.2.4 Handling, Storing, and Erecting

- (1) In handling the aluminum truss section and trusses, use covered chains or steel cables to lift or move them. Handle this material in a manner that does not permanently damage them.
- (2) Store aluminum material, either plain or fabricated, above the ground on platforms, skids, or other suitable supports. Keep the material free from grease, dirt, and contact with dissimilar metals.
- (3) Before laying out or working on, ensure all material is straight. If straightening is necessary, perform it by methods that will not injure the strength or appearance of the metal. The engineer will reject material with sharp kinks or bends.
- (4) Assemble all the truss sections that make up any one sign bridge in the shop, and adjust to the proper alignment and camber as the plans show. Matchmark all truss sections and shims before disassembly. In the field, assemble the truss sections on the ground, and erect on the columns in one piece.
- (5) Erect the columns on the leveling nuts to a true vertical position and then securely tighten the top nuts to the casting, allowing for approximately 3 inches (75 mm) of grout under the casting. Coat the anchor bolt holes in the casting, and the top of the base under the anchor bolt washers with an engineer-approved aluminum impregnated caulking compound.
- (6) The contractor shall not erect aluminum sign bridges until after attaching the required dampeners.

641.3.3 Steel Sign Bridges

- (1) Perform welding as specified for welding in [506.3.19](#). Inspect all welds visually, additionally, if the engineer determines, test all butt welds in main, stress-carrying members subject to tension or stress reversal by radiographic or ultrasonic methods over the entire length of the weld. Test other butt welds in these members by the same methods, except the engineer will determine the length of weld to test. Use either the dye penetrant method, or the magnetic particle method to test the fillet welds described in [641.3.2.3.6](#). Perform the dye penetrant test according to the method described in [641.3.2.3.6](#), inspection, and perform the magnetic particle method according to the applicable requirements of ASTM E 709. Furnish all materials, equipment, and personnel to perform this inspection at no expense to the department.
- (2) Blast clean and then zinc coat the fabricated sign bridge trusses, columns, and their steel accessories after completing all cutting, punching, drilling, and welding.
- (3) After zinc coating, assemble the individual members making up the truss sections (unless fabricated and zinc coated in one piece) in the shop, adjust to the proper shape and alignment, and tighten the high strength bolts to the required tension. Then, assemble the truss sections that make up any one sign bridge in the shop, and adjust to proper alignment and camber as the plans show. Matchmark all truss sections and shims before disassembling for shipment.

- (4) Place the leveling nuts on the anchor bolts at the proper elevation above the concrete, then erect the columns on them to a true vertical position, and securely tighten the top nuts.
- (5) Assemble the sections making up the truss, together as a single unit, before attaching to the columns.
- (6) Repair all zinc coating chipped off or damaged in handling or transporting by field zinc coating as specified for repair in [635.3.4](#).
- (7) Construct the aluminum handrail, including fabrication and erection, as specified for aluminum sign bridges in [641.3.2](#).

641.3.4 Overhead Sign Supports

- (1) Under the Overhead Sign Support bid item, furnish and erect commercially designed sign supports, fabricated from aluminum or steel, consisting of pole shafts, mast arms, anchor bolts, hardware, concrete supports and all other items necessary to complete the work.
- (2) Construct the sign supports according to the manufacturer's instructions. Erect the pole shafts for the sign supports after the concrete footings have cured for 7 days.

641.4 Measurement

- (1) The department will measure the Sign Bridge Single Pole Sign Support One Sign, Sign Bridge Single Pole Sign Support Two Signs, Sign Bridge Cantilevered, Sign Bridge Structure Mounted, and Sign Bridge bid items as a single lump sum unit for each sign bridge acceptably completed.
- (2) The department will measure the Overhead Sign Support bid items as a single lump sum unit for each overhead sign support acceptably completed.

641.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
641.0100	Sign Bridge Single Pole Sign Support One Sign (structure)	LS
641.0600	Sign Bridge Single Pole Sign Support Two Signs (structure)	LS
641.1200	Sign Bridge Cantilevered (structure)	LS
641.5100	Sign Bridge Structure Mounted (structure)	LS
641.6600	Sign Bridge (structure)	LS
641.8100	Overhead Sign Support (structure)	LS

- (2) Payment for the Sign Bridge Single Pole Sign Support One Sign, Sign Bridge Single Pole Sign Support Two Signs, Sign Bridge Cantilevered, Sign Bridge Structure Mounted, and Sign Bridge bid items is full compensation for providing all materials, including anchor bolts, dampeners if required in the structure plans, but not including concrete supports paid for separately as specified in [section 636](#); for fabricating, including all cutting, preparing, welding, and zinc coating; and for transporting and erecting. Sign lighting, when required, is paid for separately as specified in [section 659](#). Signs and sign brackets are paid for separately as specified in [section 637](#).
- (3) Payment for the Overhead Sign Support bid items is full compensation for designing the sign support structure including required concrete supports; for excavating; for providing all materials, including anchor bolts, pole shafts, mast arms, required reinforcing steel, and concrete; for fabricating, including all cutting, preparing, welding, and zinc coating; for placing and curing concrete supports; and for transporting and erecting. Sign lighting, when required, is paid for separately as specified in [section 659](#). Signs and sign brackets are paid for separately as specified in [section 637](#).

SECTION 642 FIELD FACILITIES

642.1 Description

- (1) This section describes furnishing, placing or erecting, equipping, and maintaining field offices and field laboratories as required by the contract at engineer-approved locations.

642.2 Materials

642.2.1 General

- (1) Provide field offices and field laboratories that are mobile, house-type trailers, or houses, or other engineer-approved types that are floored, roofed, and weatherproofed, and have a minimum ceiling height of 6 feet-9 inches (2.06 m).
- (2) Equip these facilities with suitable artificial lighting and adequate heating equipment along with the necessary fuel to maintain a minimum temperature of 68 F (20 C) during the hours occupied.
- (3) Provide and maintain an adequate supply of bottled drinking water.
- (4) Provide and maintain suitable interior or exterior sanitary facilities conforming to State and local health requirements, in clean and good working condition, and stock with sanitary supplies for the duration of the contract.
- (5) Supply a first aid kit in each field office and field laboratory provided under the contract. Ensure the kits are readily accessible to project personnel. Check the contents of each kit at least once each week and replenish expended items. Ensure each kit contains, at a minimum, a supply of latex or nitrile gloves, CPR masks, adhesive tape, pressure and cling bandages, antiseptic wipes, bite/sting swabs, cold packs, and safety goggles.
- (6) For situations that may expose the eyes or body of a worker to corrosive or potentially harmful materials, provide emergency use facilities capable of flushing the eyes, or drenching the body of an exposed worker with water for 15 minutes.
- (7) Provide at least 4 windows, positioned for cross ventilation, and equipped with required locks and screens. Securely fasten heavy screening over all windows. Use screening made of No. 2 mesh, 14-gauge or heavier, steel wire cloth, zinc coated after weaving.
- (8) Equip with a 6-pound (2.7kg) or larger fire extinguisher conforming to class A, B, and C of the NFPA Code.
- (9) Equip the exterior doors with heavy-duty clasps bolted through the door and jamb with heavy-duty padlocks.

642.2.2 Field Office

642.2.2.1 General

- (1) Provide the field office with 2 telephones, one with an answering device, and 3 exchange services. The telephones are for the sole use of the department staff.
- (2) Provide each field office with two rooms, separated by an interior door equipped with a padlock, and each room shall have a separate exterior door.
- (3) Provide for an air conditioner for each room.
- (4) Furnish a plain paper fax machine.
- (5) Equip with a suitable drafting table with a drafter's stool.

642.2.2.2 Type B

- (1) Under bid item Field Office Type B, furnish a facility with minimum exterior dimensions of 8 feet (2.44 m) wide and 20 feet (6.10 m) long, excluding hitch, and equip according to [642.2.2.1](#)

642.2.2.3 Type C

- (1) Under bid item Field Office Type C, furnish a facility with minimum exterior dimensions of 10 feet (3.05 m) wide and 30 feet (9.15 m) long, excluding hitch, and equipped [642.2.2.1](#) and with the following:
 1. Two suitable office desks with drawers and locks.
 2. Two office chairs.
 3. Three folding chairs.

642.2.2.4 Type D

- (1) Under bid item Field Office Type D, furnish a facility with minimum exterior dimensions of 10 feet (3.05 m) wide and 30 feet (9.15 m) long, excluding hitch, and equipped [642.2.2.1](#) and with the following:
 1. Three suitable office desks with drawers and locks.
 2. Three office chairs.
 3. Two folding tables.
 4. Nine folding chairs.

642.2.3 Field Laboratory

- (1) Under the Field Laboratory bid item, furnish a facility of minimum exterior dimensions of 8 feet (2.44 m) wide and 16 feet (4.88 m) long, excluding hitch, and equip with [642.2.2.1](#) requirements unless otherwise specified and the following:
 1. A suitable workbench.
 2. At least 15 linear feet (4.6 m) of shelving, approximately 14 inches (350 mm) wide.
 3. An adequate water supply for testing purposes.
 4. One air conditioner.
- (2) If using the laboratory for HMA pavement work, equip it with a suitable fan with a minimum capacity of 1000 cubic feet (28.4 m³) per minute, in good working condition. Install the fan in an outside wall above the work bench used for asphalt extraction testing. Enclose the fan inlet and work bench top in a suitable hood or enclosure that allows effective removal of the fumes from the extraction testing.

642.3 Construction

- (1) Do not combine field offices and field laboratories, or combine them with, or attached them to, any buildings used by the contractor, unless the engineer allows in writing.
- (2) Anchor or secure the field offices and field laboratories to prevent them from overturning by high velocity winds. Locate the field office in a dust-reduced and vibration-free environment.
- (3) Do not begin construction operations requiring the use of the field office and laboratory by the department, until the required field office and laboratory are furnished, leveled, secured, fully equipped, and made ready for use at the locations the engineer directs.
- (4) The field office and laboratory shall remain available for department use until the project engineer approves their closure or removal.
- (5) These field facilities are for the sole use of the department and upon contract completion remain the contractor's property.
- (6) The contractor may furnish, if the contract allows, the field office and field laboratory facilities jointly in cooperation with other contractors on designated projects.

642.4 Measurement

- (1) The department will measure the Field Office and Field Laboratory bid items as a single unit for each field office and laboratory acceptably completed.

642.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
642.5000 - 5999	Field Office (type) (project)	EACH
642.6000	Field Laboratory (project)	EACH

- (2) Payment for the Field Office and Field Laboratory bid items is full compensation for providing, equipping, securing, and maintaining the facility; and for providing bottled water, utilities, fuel, ventilation, and toilet facilities as required, either independently or jointly, for the time specified in [642.3](#).
- (3) The department will pay for the cost of toll service or telegrams incurred by department staff.

SECTION 643 TRAFFIC CONTROL

643.1 Description

- (1) This section describes providing, erecting, maintaining, moving, and removing temporary traffic signs, and demountable legend plaques, pavement markings, drums, barricades, flexible tubular markers, arrow boards, and lights.

643.2 Materials

643.2.1 General

- (1) Furnish materials conforming to the MUTCD and maintain traffic control devices as follows:
 - 1. Keep the retroreflective sheeting on drums, barricades, and other devices clean.
 - 2. Promptly repair scratches, rips, and tears in the sheeting.
 - 3. Repair or replace devices that have large areas of abrasion, missing reflective sheeting, asphalt splatter, concrete slurry, or other residue.
 - 4. Replace devices that have excessive color fading.
 - 5. The contractor shall not use devices that are fractured, punctured, dented, or deformed severely enough to affect the overall dimensions, stability, visibility, or reflectivity.
 - 6. Maintain the retro-reflectance of all drums, posts, and barricades at a level not less than 50 percent of the minimum value specified in [637.2.2.2](#) for type H reflective sheeting.

643.2.2 Temporary Pavement Markings

- (1) Provide temporary pavement marking materials conforming to [649.2](#).

643.2.3 Drums

- (1) Provide nonmetallic reflectorized traffic control drums fabricated to accept type C or type A warning lights. All drums must conform to the crashworthiness criteria of NCHRP Report 350, test level 3. If the engineer requests, furnish a letter from the manufacturer or distributor certifying that the drums conform to those crashworthiness criteria.
- (2) Provide reflective sheeting on all drums. The reflective sheeting material must conform to all the following:
 - 1. Designed specifically for use on reboundable traffic control devices.
 - 2. Conform to [637.2.2.2](#) for type H reflective sheeting.
 - 3. Received a good or better rating in 1-year NTPEP tests for shrinkage, cracking, blistering, colorfastness, reflectivity, adhesion, flexibility, and impact resistance.
- (3) Weight each drum with sand bags, or other engineer-approved material, to keep the drum in its intended location. The contractor shall not fasten together, or alter otherwise, 2-piece drums to perform in a way the manufacturer did not intend.

643.2.4 Barricades

- (1) Provide reflective sheeting on all barricades. The reflective sheeting material must conform to all the following:
 - 1. Designed specifically for use on rigid traffic control devices.
 - 2. Conform to [637.2.2.2](#) for type H reflective sheeting.
 - 3. Received a good or better rating in 1-year NTPEP tests for shrinkage, cracking, blistering, colorfastness, reflectivity, adhesion, and impact resistance.
- (2) Provide barricades conforming to the crashworthiness criteria of NCHRP Report 350, test level 3. If the engineer requests, certify in writing that those crashworthiness criteria are met. Include the FHWA acceptance letter WZ-number in that written certification.
- (3) For type III barricades with no sign attached, provide barricades 8 feet (2.4 m) long unless the contract indicates otherwise or the engineer approves otherwise. For type III barricades with a sign attached, provide barricades 4 feet (1.2 m) or longer.

643.2.5 Flexible Tubular Markers

643.2.5.1 Flexible Tubular Marker Posts

- (1) Provide flexible tubular posts with reflective sheeting as the plans show.
- (2) Use flexible tubular marker posts made with materials resistant to extreme temperature changes in the range of -20 F to 160 F (-29 C to 71 C), ultraviolet light, ozone, hydrocarbons, stiffening with age, and a series of direct wheel impacts with speeds varying up to 65 mph (105 km/h), and rebounds to a vertical position if struck by a standard vehicle. Select flexible tubular marker posts from the department's approved products list. Obtain this list from the technology advancement unit of the bureau of highway construction. The posts must conform to the crashworthiness criteria of NCHRP report 350, test level 3. If the engineer requests, furnish a letter from the post manufacturer or distributor that certifies that the posts conform to the NCHRP 350 crashworthy requirements. Provide posts that exhibit good quality, are free of burns, discoloration, contamination and other objectionable marks or defects that affect appearance or serviceability.
- (3) Provide reflective sheeting for the flexible tubular marker posts conforming to [637.2.2.2](#) and that is suitable to use on reboundable traffic control devices. Use sheeting having acceptable performance and good evaluation ratings in 1-year NTPEP tests, for shrinkage, cracking, blistering, colorfastness, reflectivity, adhesion, flexibility, and impact resistance.
- (4) Provide new and unused flexible tubular marker posts if installed at a new location. The contractor may furnish used posts in like-new condition, with new reflective marking installed on the post, as replacement posts.

643.2.5.2 Flexible Tubular Marker Bases

- (1) Provide a surface mounted assembly that either bolts to the pavement surface using an engineer-approved or specified bolt adhesive system, or attaches using an engineer-approved or specified asphaltic adhesive. Provide a base designed to hold the post securely using locking pins, or other devices, to withstand a series of direct wheel impacts with speeds up to 65 mph (105 km/h).
- (2) On all temporary pavements, or existing pavements later removed, the contractor may attach the base with an epoxy adhesive, or core the pavement and install a sleeve type base as the plans show.

643.2.6 Arrow Board

643.2.6.1 General

- (1) Provide arrow boards conforming to the MUTCD requirements for type C arrow panels.
- (2) Furnish, service, maintain, repair, or replace the arrow boards as necessary. Arrow boards remain the contractor's property.

643.2.6.2 Sign Panel

- (1) Provide sign panels 48 inches by 96 inches (1220 mm by 2440 mm), non-reflective flat black, trailer mounted, and capable of operating in a stationary setup and while being towed, except, operate solar arrow boards only in stationary setups.
- (2) Provide sign panels with at least 15 SAE PAR 46 lamps per panel. Configure the lamps according to Part VI of the MUTCD. Use sealed beam type lamps with yellow lenses, or amber bulbs behind clear lenses, equipped with an upper hood that surrounds not less than 180 degrees of the lamp.
- (3) Provide arrow boards capable of these mode selections: left or right flashing shaft with arrow point, flashing shaft with double arrow points, or caution. The engineer will not allow sequential operation of arrow or chevrons.
- (4) Ensure the arrow board is continuously visible and identifiable for a distance of one mile (1.6 km) in advance of the beginning of the lane closure taper. Ensure the lamps are visible at a minimum 18 degrees horizontal angle and 8 degrees vertical angle, measured from a perpendicular to the arrow board plane.

643.2.6.3 Control System

- (1) Provide electronically operated lamps controlled by a solid-state controller mounted to the frame in a weatherproof, ventilated, lockable enclosure.

- (2) Provide lamps capable of at least 50 percent dimming from their rated voltage. The flashing rate shall range from 25 to 40 flashes per minute. Ensure a minimum lamp "on" time of 50 percent. Ensure no lamps remain illuminated during "off" time. The control system shall provide for automatic dimming of lamps by reducing the voltage to 50 percent minimum for nighttime use and for the fail mode default setting. Provide a manual override backup switch.
- (3) Include with battery/solar powered arrow boards: a 120 volt AC/12 volt DC battery charger and voltage regulator with standard receptacles, a battery condition indicator with test switch, and a current meter.

643.2.6.4 Power Supply

- (1) Provide a reliable energy supply for arrow boards, this supply might be self-contained batteries, solar, a diesel fueled generator, gasoline fueled generator, or electricity from a utility company. If using batteries as the primary power source, they must provide sufficient voltage, between charging, to each of the lamps to provide at least 15 days of continuous operation, in any mode, at full daytime intensity.
- (2) Equip diesel/generator and gasoline/generator powered units with a fuel tank of sufficient capacity to operate at least 24 hours without refueling and designed to minimize the danger of rupture or explosion in case of collision. The contractor shall not store additional fuel on or near the trailer.
- (3) Provide an auxiliary power supply, available immediately, on the site in case the primary power supply fails.

643.2.7 (Vacant)

643.2.8 Hand Signaling Devices

- (1) Use the sign paddle as the primary hand-signaling device. Limit flag use to emergency situations. Mount the sign paddle on a rigid handle with a 5-foot (1520 mm) minimum mounting height to the bottom of the sign.

643.2.9 Signs

643.2.9.1 General

- (1) Layout signs according to the FHWA Manual of Standard Highway Signs or the department's Sign Plate Book, unless the plans show otherwise.
- (2) Provide the sign size the contract specifies. If the contract does not specify the size, provide the size the MUTCD specifies for higher-speed locations or a larger size, except the engineer may allow smaller signs if space is limited and the MUTCD allows.
- (3) Use the materials and methods specified in [section 637](#), for type II signs, to manufacture and assemble signs. In addition, the contractor may use the following:
 - 1. For any sign, an exterior grade A-B plywood sign base 1/2-inch (13 mm) or thicker.
 - 2. For signs mounted on portable sign supports or barricades, one or more of the following:
 - 2.1 A sheet aluminum sign base 0.080 inches (2.0 mm) or thicker.
 - 2.2 A corrugated polypropylene or polyethylene plastic sign base.
 - 2.2.1 Provide a base 0.4 inches (10 mm) thick with wall thickness of 0.035 inches (0.9 mm) and cell size of 0.4 inches (10 mm).
 - 2.3 An aluminum/plastic laminate sign base.
 - 2.3.1 Provide an aluminum faced composite base 0.080 - 0.100 inches (2.0-2.5 mm) thick, with aluminum outer layers 0.010 - 0.020 inches (0.25-0.50 mm) thick surrounding a core of polyethylene or other thermoplastic material.
 - 2.4 A retroreflective roll-up sign.
- (4) Prepare the sign base as the sheeting manufacturer recommends.
- (5) Provide a sign support system as follows:
 - 1. For signs mounted on posts, use posts from the FHWA list of accepted breakaway sign supports. ^[1]
 - 2. For signs mounted on portable sign supports or barricades, use signs and supports conforming to the crashworthiness criteria of NCHRP Report 350, test level 3 as follows: ^[1]
 - 2.1 For all signs on National Highway System routes.
 - 2.2 For all roll-up signs.

^[1] If the engineer requests, provide written certification that the breakaway or crashworthiness criteria are met. Include the FHWA acceptance letter WZ-number or SS-number in that written certification.

- (6) Provide sign face material for signs R1-1 stop, R1-2 yield, R5-1 do not enter, and R5-1a or R5-9 wrong way conforming to [637.2.2.2](#) for type H reflective sheeting. For all other sign face material, provide standard reflective sheeting conforming to [637.2.2.1](#), except as specified in the contract, or in [643.2.9.2](#) for orange work zone traffic control signs.
- (7) If a sign has an associated secondary sign mounted on the same assembly, ensure that the color of the secondary sign matches the primary sign unless the plans show, or the engineer directs, otherwise.
- (8) Stencil all messages and borders directly on the sign background of standard construction signs, except as specified in [643.2.9.4](#) for sign overlays.
- (9) Keep the retroreflective sheeting on signs clean. Promptly repair scratches, rips, and tears in the sheeting. Repair or replace signs with abrasions, asphalt splatter, or concrete slurry on the sign face that makes the message or any letters illegible. Replace signs with noticeable color fading.
- (10) Maintain the level of retroreflectance for signs as follows:
 1. Standard reflective sheeting; 75 % of the minimum value specified in [637.2.2.1](#) or greater.
 2. Type H reflective sheeting; 50 % of the minimum value specified in [637.2.2.2](#) or greater.
 3. Prismatic reflective sheeting; 50 % of the minimum value specified in [643.2.9.2](#) or greater.

643.2.9.2 Orange Work Zone Traffic Control Signs

- (1) For sign face material, provide fluorescent orange, prismatic, retroreflective sheeting with a minimum initial coefficient of retroreflection as follows:

OBSERVATION	ENTRANCE	MINIMUM INITIAL COEFFICIENT OF RETROREFLECTION
ANGLE	ANGLE	in either cd/ft ² or cd/lx/m ²
0.2 deg	-4 deg	200
0.2 deg	+30 deg	92
0.5 deg	-4 deg	80
0.5 deg	+30 deg	32

- (2) Conform to the sheeting color chromaticity coordinates and the minimum luminance factor as follows:

SHEETING COLOR	CHROMATICITY COORDINATES								LUMINANCE FACTOR
	1		2		3		4		Y MINIMUM
	X	Y	X	Y	X	Y	X	Y	
Orange	0.562	0.350	0.645	0.355	0.570	0.429	0.506	0.404	28%

- (3) The department may require independent verification of the initial coefficient of retroreflection and sheeting color.
- (4) The contractor may use standard reflective sheeting conforming to [637.2.2.1](#) for the following:
 1. G20-2a end road work signs.
 2. M4-9/M4-8 series detour signs, and MO5-x/MO6-x arrow plaques used in detour sign assemblies.
 3. Special fixed message signs as specified in [643.2.9.3](#).
 4. Orange plaques that supplement or cover a portion of existing green guide signs.
- (5) If using plywood sign bases with fluorescent orange prismatic sheeting, use new plywood. For other sign base types, the contractor may use a reconditioned base if all previous sheeting materials are removed before applying the new fluorescent orange prismatic sheeting. Do not remove messages and reapply new messages to existing signs with prismatic sheeting, except as specified for overlays in [643.2.9.4](#).

643.2.9.3 Fixed Message Signs

- (1) For the sign base, provide a good exterior grade A-B plywood with a 1/2 inch (13 mm) minimum thickness. Provide reflective sheeting conforming to [637.2.2.1](#) for standard reflective sheeting and provide sign message material conforming to [637.2.3.4](#) for stencil paste.

643.2.9.4 Sign Message Overlays

643.2.9.4.1 General

- (1) The contractor may alter the message on standard construction signs by applying demountable plaque overlays or direct-applied, pressure-sensitive sheeting overlays. Do not apply more than one overlay per sign. The contractor shall not encompass more than one line of the sign message with the overlay. On W20-5 or W20-58 series signs, the contractor may use 2 overlays to independently alter the right/left lane message and the ahead/distance message.
- (2) The message on the demountable plaque or sheeting overlay shall conform to the FHWA Manual of Standard Highway Signs or the department's Sign Plate Book, and match the specified letter height, letter series, and letter stroke width of the message on the sign on which mounting the plaque or overlay.
- (3) Ensure that the reflectivity and the color of the sheeting on the plaque or sheeting overlay, and the base sign are similar enough that the composite sign, both daytime and nighttime appearance, exhibits the visual impact of one integral sign.
- (4) Match the sign face material for overlays to the base sign reflective sheeting material.
- (5) The contractor shall not use sign overlays for non-word messages, except for the lane reduction transition sign, WO4-2.

643.2.9.4.2 Demountable Plaque Overlay

- (1) For the base material, use sheet aluminum conforming to [637.2.1.3](#).
- (2) Use reflective sheeting for sign face material conforming to the requirements for signs in [643.2.9](#).
- (3) Apply the sign message using stencil paste conforming to [637.2.3.4](#) and [637.3.2.5](#).

643.2.9.4.3 Sheeting Overlay

- (1) Use pressure-sensitive sheeting conforming to the requirements for signs in [643.2.9](#).

643.2.9.5 Sign Covering Material

- (1) Use material of sufficient durability to withstand the effects of weathering, but will not damage the reflective face of the sign, during the time the covering is used. Do not apply any kind of tape to the face of the sign to fasten covering material.

643.3 Construction

643.3.1 General

- (1) Perform this work according to part VI of the MUTCD for temporary traffic controls except as noted below, in the contract, and as the engineer directs.
- (2) Under the Traffic Control bid items, perform all of the work described below, except work specifically covered by other traffic control and pavement marking items contained in the contract.
- (3) Under the Traffic Control Drums bid item, furnish, install, maintain, move, and remove traffic control drums.
- (4) Under the Traffic Control Barricades bid items, furnish, install, maintain, move, and remove barricades of the specified type.
- (5) Review all traffic signs and control devices furnished and erected for location, position, visibility, adequacy, and manner of use under specific job conditions immediately after each setup and at least once every 24 hours and more frequently as necessary, to ensure all the signs and control devices are continuously in compliance with this section. Review the signs and devices from the same direction that approaching traffic views them.
- (6) Provide equipment, forces, and materials to promptly restore any traffic control devices or pavement markings damaged or disturbed.
- (7) All traffic control devices remain the property of the contractor upon completion of the work unless specified otherwise.
- (8) On the back face of each sign, a rail of each barricade, and on each drum and arrow board place the name and telephone number of the agency, contractor, supplier, or person responsible for 24-hour emergency service. Provide this information in non-reflective letters at least 3/4 inch (19 mm) but no more than 2 inches (50 mm) high.

- (9) If the plans or special provisions contain specific sign details, sequence of erection or special instructions for handling traffic, conform to them unless the engineer directs otherwise.
- (10) Ensure the proper placement and operation of all signs and control devices before beginning construction work affected by those signs or devices. If performing work of a progressive nature, like resurfacing operations on a road open to traffic, then relocate the signs concurrently.
- (11) If, in the engineer's judgment, the contractor has not provided and maintained proper provisions for traffic control according to these specifications, the engineer may restrict construction operations affected by defective signs, devices, or markings until the contractor establishes and maintains the proper provisions. The department may also take steps to place them in proper condition at no expense to the department.

643.3.2 Surveillance and Maintenance

- (1) Under the Traffic Control Surveillance and Maintenance bid items, provide personnel to inspect and maintain the traffic control devices, furnished, and installed, in proper condition.
- (2) If this bid item is included in the contract, provide one person, called the traffic control specialist, responsible for inspecting and maintaining traffic control signs or devices; the contractor may need to provide other personnel to accomplish the inspection and maintenance; and provide all necessary vehicles, equipment, tools, and repair materials.
- (3) Inspection and maintenance includes all traffic control signs or devices included in the contract, including those on detour routes. Begin when the first traffic control sign or device is put into operation and end when the last traffic control sign or device is removed from operation.
- (4) The traffic control specialist shall inspect the traffic control signs and devices at least once each calendar day during daytime hours. During the inspection, clean, repair, or replace each traffic control sign or device not performing as intended, as necessary.
- (5) The control specialist shall also inspect each reflective traffic control sign or device at least once each week during hours of darkness. View the signs and devices using low beam vehicle headlights to ensure reflectorization is unimpaired. Clean, repair, or replace each reflectorized traffic control sign or device not performing as intended, as necessary, before sunset of the next calendar day, or as the engineer directs otherwise.
- (6) Before each workday daytime or night inspection, the control specialist shall meet with the department representative responsible for traffic control under the contract to discuss possible problems with the existing traffic control.
- (6) The control specialist shall submit a written report weekly to the project engineer. The report shall document the daily daytime and weekly night inspections.
- (7) Make the control specialist, or other contractor designated person, available 24 hours per day, 7 days per week to clean, repair, or replace traffic control devices not performing as intended throughout the period traffic control signs and devices are operating under this contract. Provide to the engineer, the County Sheriff, and the State Patrol District Headquarters responsible for that county the telephone number to contact the control specialist or other contractor designated person. Ensure that the control specialist, or other designated person, is able to reach any location within the contract limits, or on detour routes, within 2 hours of being contacted, and can promptly accomplish the necessary cleaning, repair, or replacement.

643.3.3 Temporary Pavement Markings

- (1) Apply as specified for temporary pavement markings in [649.3](#).

643.3.4 Flexible Tubular Markers

643.3.4.1 Posts

- (1) Under the Traffic Control Flexible Tubular Marker Posts bid item, furnish, install, maintain, and remove flexible tubular marker posts with reflective sheeting.
- (2) Attach the posts to the base using a locking pin or other engineer-approved system.

643.3.4.2 Bases

- (1) Under the Traffic Control Flexible Tubular Marker Bases bid item, furnish, install, maintain, and remove bases for flexible tubular marker posts.

- (2) Use bases designed for temporary installation that resist twisting or displacement from impact forces, and do not pose a hazard to vehicles.
- (3) Remove the base in a manner that does not damage the final pavement. Repair all damaged pavement at no expense to the department. Remove bolts flush with the pavement surface; no part of the bolts may protrude above the pavement surface.

643.3.5 Warning Lights

- (1) Under the Traffic Control Warning Lights bid items, furnish, install, maintain, move, and remove the specified warning lights.

643.3.5.1 High Intensity Flashing Warning Lights

- (1) Install type B, high Intensity flashing, warning lights on warning signs or barricades as the plans show or the engineer directs.
- (2) Mount each light installed with a warning sign on the back of the sign. Position the light so that the lens is outside the edge of the sign, to the traffic side, and between the midpoint and the top of the sign. Use a one-way light or lens-directed light visible only to traffic approaching the message side of the sign, unless the engineer orders otherwise.

643.3.5.2 Low Intensity Flashing and Steady Burn Warning Lights

- (1) Install type A, low intensity flashing, or type C, steady burn, warning lights on traffic control drums, barricades, and signs as the contract specifies or the engineer directs. Warning light attachments must conform to the crashworthiness criteria of NCHRP Report 350, test level 3 as follows:
 - 1. Traffic control drums: Firmly affix the warning light to the drum with vandal resistant hardware. If the engineer requests, furnish a letter from the manufacturer or distributor certifying that the drums and warning light attachments conform to NCHRP crashworthiness criteria.
 - 2. Barricades used on National Highway System routes: If the engineer requests, certify in writing that the barricades and warning light attachments conform to NCHRP crashworthiness criteria.
- (2) Mount each type A light installed in conjunction with a warning sign on the back of the sign. Position the light so that the lens is outside the edge of the sign, to the traffic side, and between the midpoint and the top of the sign, unless the plans show otherwise. Use a one-way light or lens-directed light visible only to traffic approaching the message side of the sign, unless the engineer orders otherwise.
- (3) The engineer will not require type A lights on signs with fluorescent, or non-fluorescent orange prismatic retroreflective sheeting.

643.3.6 Arrow Boards

- (1) Under the Traffic Control Arrow Boards bid item, furnish, install, maintain, move, and remove arrow boards.
- (2) Operate all arrow boards during the hours of darkness at an illumination level of not more than 50 percent of the daytime level.
- (3) Place arrow boards as the plans show, or as the engineer directs. The engineer will not allow the display of an arrow or chevrons by lighting in sequence from left to right, or right to left.
- (4) Remove and replace any arrow board that repeatedly fails with a properly functioning arrow board.

643.3.7 (Vacant)

643.3.8 Signs

643.3.8.1 General

- (1) If the sign message is no longer relevant, promptly remove it or cover the sign face completely so that the reflectivity and message are not evident.
- (2) Install post-mounted temporary traffic control signs with the bottom of the sign 7 feet (2.1 m) or higher above the top of curb or near edge of pavement. In rural areas with no view obstructions, the contractor may reduce the minimum mounting height to 5 feet (1.5 m). Mount associated secondary signs no lower than one foot (0.3 m) below these minimums. Do not install signs on existing posts unless the plans show or the engineer or post owner allows.
- (3) Trim posts neatly with top of sign, so that no portion of the post protrudes above the sign.

643.3.8.2 Traffic Control Signs

- (1) Under the Traffic Control Signs bid item, furnish, install, maintain, move, and remove temporary traffic signs including all posts and other sign supports.

643.3.8.3 Fixed Message Signs

- (1) Under the Traffic Control Signs Fixed Message bid item, furnish, install, and remove fixed message signs, including all posts.
- (1) If fastening a fixed message sign to an existing sign, completely cover the underlying sign message that is not applicable. Securely attach the fixed message sign to the existing sign using a sufficient number of bolts or screws, but do not use tape.
- (2) Install post-mounted fixed message signs at the height specified in [643.3.8.1](#). If the sign is larger than 50 square feet (5 m²), install with the bottom of the sign at least 7 feet (2.1 m) above the ground.

643.3.8.4 Sign Message Overlays

- (1) The contractor may overlay a direct-applied sheeting overlay by additional sheeting overlays, or by a demountable plaque. Do not overlay a demountable plaque overlay with another demountable plaque or by sheeting.
- (2) Use an overlay conforming to the sign message overlay specified in [643.2.9.4](#).
- (3) Non-word messages cannot be a sign overlay, except for the lane reduction transition sign, WO4-2.
- (4) Fasten the plaque overlay to the base sign with 4 bolts or screws, one in each corner of the plaque. Apply sheeting overlays so that no curling or lifting of the overlay occurs during the sign's usage. Promptly replace the sign if any part of the overlay curls or lifts.
- (5) Position the plaque or sheeting overlay on the base sign so that they appear to be an integral part of the message. Ensure that the plaque or sheeting overlay completely covers the underlying sign message that is no longer applicable. Do not overlay any other part of the base sign message, or let it extend beyond the base sign border.

643.3.8.5 Traffic Control Detour Signs

- (1) Under the Traffic Control Detour Signs bid item, furnish, erect, maintain, review, and remove signs, including all posts and other sign supports, on the designated detour or detours.
- (2) Erect signing at engineer-approved locations. Use engineer-approved mounting methods.
- (3) Cover all detour signs placed before the detour takes effect until needed.
- (4) If the detour signing occurs on a county or local road, coordinate with the local jurisdiction about placing the detour signing on existing posts.
- (5) Place all requested additional signing within 48 hours of the engineer's notification.
- (6) Immediately remove or cover signing when the detour is no longer in effect.

643.3.9 Traffic Control Detour

- (1) Under the Traffic Control Detour bid items, perform all work necessary to sign the designated detour or detours including but not limited to flagging and guiding of traffic and covering or uncovering signs, except that work specifically covered by other contract bid items for detour traffic control is not included under this item.
- (2) Partially or fully cover any sign messages conflicting with detour traffic as the plans show or as the engineer directs.

643.4 Measurement

643.4.1 Traffic Control

- (1) The department will measure the Traffic Control (project) and Traffic Control Detour (project) bid items as each individual unit of work acceptably completed and will not include any work performed under other specific traffic control or pavement-marking contract bid items.

643.4.2 Traffic Control Surveillance and Maintenance

- (1) The department will measure the Traffic Control Surveillance and Maintenance bid items by the day acceptably completed. The measured quantity will equal the number of calendar days from the date the first traffic control sign or device is placed into operation through the date the last traffic control sign or device is removed from operation.

643.4.3 Traffic Control Items

- (1) The department will measure Traffic Control Arrow Boards, Traffic Control Drums, the Traffic Control Barricades bid items, the Traffic Control Warning Lights bid items, and Traffic Control Signs by the day acceptably completed. The measured quantity will equal the number of calendar days the sign or device is in use. For each day that the device or sign is out of service for more than 2 hours, when it is required, will result in one day being deducted from the quantity measured for payment.
- (2) The department will measure Traffic Control Detour Signs by the day acceptably completed. The measured quantity will equal the number of calendar days the sign is in use. The department will measure each sign of an assembly separately for payment. If any sign of an assembly is missing or does not comply with specifications, the department will not measure any of the signs on that assembly for the days the sign is missing or is not in compliance.
- (3) The department will not measure a traffic control sign or device on days that the bid item is not required, as the engineer determines.
- (4) The department will measure Traffic Control Flexible Tubular Marker Posts and Traffic Control Flexible Tubular Marker Bases as each individual installation and removal acceptably completed. The department will measure replacing damaged posts and bases by each post and base replaced.
- (5) The department will measure Traffic Control Signs Fixed Message by the square foot acceptably completed, measured as the area of the sign face.

643.5 Payment

643.5.1 General

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
643.0100	Traffic Control (project)	EACH
643.0200	Traffic Control Surveillance and Maintenance (project)	DAYS
643.0300	Traffic Control Drums	DAYS
643.0400 - 0499	Traffic Control Barricades (type)	DAYS
643.0500	Traffic Control Flexible Tubular Marker Posts	EACH
643.0600	Traffic Control Flexible Tubular Marker Bases	EACH
643.0700 - 0799	Traffic Control Warning Lights (type)	DAYS
643.0800	Traffic Control Arrow Boards	DAYS
643.0900	Traffic Control Signs	DAYS
643.1000	Traffic Control Signs Fixed Message	SF
643.2000	Traffic Control Detour (project)	EACH
643.3000	Traffic Control Detour Signs	DAYS

643.5.2 Traffic Control

- (1) Payment for the Traffic Control (project) bid items is full compensation for constructing, assembling, painting, hauling, erecting, re-erecting, maintaining, restoring, and removing traffic signs, drums, barricades, and similar control devices, including arrow boards, unless provided otherwise; for providing, placing, and maintaining lights, including the fuel or power unless provided otherwise; and for providing, applying, and removing pavement markings, unless provided otherwise. If Traffic Control (project) is not specified, but is later found necessary and is required, the department will pay for this work as extra work.
- (2) Payment for the Traffic Control Detour (project) bid items is full compensation for supplying and performing all flagging and guidance services; and for providing, installing, partially or fully covering or uncovering, reviewing, maintaining, and removing signs associated with guidance services. If the bid item Traffic Control Detour (project) is not specified, but is later found necessary and is required, the department will pay for this work as extra work.

643.5.3 Traffic Control Surveillance and Maintenance

- (1) Payment for the Traffic Control Surveillance and Maintenance bid items is full compensation for providing all labor, materials, tools, equipment, vehicles, and incidentals, including reports and telephone charges, necessary to complete the work. The department will not pay for replaced traffic control signs or devices under this bid item; replacement is incidental to the respective contract bid item or items.

643.5.4 Traffic Control Items

- (1) Payment for Traffic Control Arrow Boards is full compensation for providing, installing, moving, and removing portable, self-contained flashing arrow boards, including auxiliary power supply.
- (2) Payment for Traffic Control Drums is full compensation for providing, installing, moving, and removing drums, including the weights.
- (3) Payment for the Traffic Control Barricades bid items is full compensation for providing, installing, moving, and removing the barricades.
- (4) Payment for the Traffic Control Warning Lights bid items is full compensation for providing, installing, moving, and removing warning lights of the specified type, including mounting hardware, batteries, and hold down devices.
- (5) Payment for Traffic Control Signs is full compensation for providing, installing, moving, and removing traffic control signs, including all posts, signs, mounting hardware, orange flags, and hold down devices.
- (6) Payment for Traffic Control Signs Fixed Message is full compensation for providing all materials; for the manufacture and assembly of the sign, including all messages; and for hauling, handling, installing and removing the signs, including posts, fasteners and necessary hardware and vertical supports.
- (7) Payment for Traffic Control Flexible Tubular Marker Posts is full compensation for providing, installing, and maintaining the flexible tubular marker posts, and for removing the posts.
- (8) Payment for Traffic Control Flexible Tubular Marker Bases is full compensation for providing, installing, and maintaining the flexible tubular marker bases; for removing bases; and for repairing damaged pavements. The department will not pay to replace bases inadequately secured to the pavement
- (9) Payment for Traffic Control Detour Signs is full compensation for providing, erecting, partially or fully covering or uncovering, reviewing, maintaining, and removing detour signs including posts, channels, signs, mounting hardware and flags.
- (10) The department will pay for temporary pavement marking bid items as specified in [649.5](#).

SECTION 645 GEOTEXTILE FABRICS

645.1 Description

- (1) This section describes furnishing and installing geotextile fabrics for subgrade separation and stabilization, drainage filtration, subgrade reinforcement, and under culverts and riprap.

645.2 Materials

645.2.1 General

- (1) Furnish geotextile fabric of either woven or nonwoven polyester, polypropylene, stabilized nylon, polyethylene, or polyvinylidene chloride. All fabric shall have the minimum strength values in the weakest primary direction. The contractor may use nonwoven fabric that is one or a combination of the following: needle punched, heat bonded, or resin bonded.
- (2) Furnish geotextile fabric that is insect, rodent, mildew, and rot resistant.
- (3) Furnish the geotextile fabric in a wrapping that protects the fabric from ultraviolet radiation and from abrasion due to shipping and hauling. Keep the geotextile dry until installed.
- (4) Clearly mark the geotextile fabric rolls to show the type of fabric.
- (5) The engineer may obtain samples of fabric for testing from the job site as specified below, or as the engineer determines.
- (6) If using sewn seams, furnish a field sewn seam sample produced from the geotextile fabric and thread and with the equipment proposing to use on the project, before incorporating into the work.
- (7) If no minimum values are specified below, use those specified in the special provisions.

645.2.2 Geotextile Fabric, Type SAS (Subgrade Aggregate Separation)

- (1) Furnish fabric conforming to the following physical properties:

TEST	METHOD	VALUE ^[1]
Minimum grab tensile strength	ASTM D 4632	170 lb. (750 N)
Minimum puncture strength	ASTM D 4833	70 lb. (300N)
Maximum apparent opening size	ASTM D 4751	No. 70 (212 μ m)
Minimum permittivity	ASTM D 4491	0.35 s ⁻¹

^[1] All numerical values represent minimum/maximum average roll values. Average test results from all rolls in a lot must conform to the tabulated values.

- (2) For quantities over 20,000 square yards (20 000 m²), furnish to the engineer, at least 10 days before use in the work, a manufacturer's certified report of test or analysis that shows the geotextile fabric delivered conforms to the above requirements. Mark the delivered geotextile fabric to clearly identify it with the applicable test report furnished to the engineer. The engineer will obtain samples of fabric for testing from the job site for each 20,000 square yards (20 000 m²) or lesser portion used in the work.

645.2.3 Geotextile Fabric, Type MS (Marsh Stabilization)

- (1) Use the following test methods to confirm the values shown in the special provisions.

TEST	METHOD	VALUE ^[1]
Minimum tensile strength (machine direction)	ASTM D 4595	___ lb/in (N/m)
Minimum tensile strength (cross direction)	ASTM D 4595	___ lb/in (N/m)
Maximum elongation at required strength	ASTM D 4595	___ %
Minimum puncture strength	ASTM D 4833	___ lb (N)
Maximum apparent opening size	ASTM D 4751	No. ___ (μ m)
Minimum permittivity	ASTM D 4491	___ s ⁻¹

^[1] All numerical values represent minimum/maximum average roll values. Average test results from all rolls in a lot must conform to the tabulated values.

- (2) Deliver to the engineer a sample of the geotextile material at least 15 days before incorporating into the work. At the same time, furnish a sewn seam sample using the same geotextile fabric, thread, seam spacing, and number, and overlap distance as are intended or required for use.

- (3) Furnish to the engineer, at least 15 days before use in the work, a manufacturer's certified report of test or analysis that shows that the geotextile fabric delivered conforms to the above requirements. Mark the delivered geotextile fabric to clearly identify it with the applicable test report furnished to the engineer. The engineer will obtain samples of fabric for testing from the job site for each 10,000 square yards (10 000 m²) or lesser portion used on the contract.

645.2.4 Geotextile Fabric, Type DF (Drainage Filtration)

- (1) Furnish fabric conforming with the physical requirements of either schedule A, schedule B, or schedule C as the contract specifies.

SCHEDULE A TEST	METHOD	VALUE ^[1]
Minimum grab tensile strength	ASTM D 4632	110 lb. (500N)
Minimum puncture strength	ASTM D 4833	40 lb. (175N)
Minimum apparent breaking elongation	ASTM D 4632	30%
Maximum apparent opening size	ASTM D 4751	300 µm
Minimum permittivity	ASTM D 4491	0.70 s ⁻¹
SCHEDULE B TEST	METHOD	VALUE ^[1]
Minimum grab tensile strength	ASTM D 4632	180 lb. (800N)
Minimum puncture strength	ASTM D 4833	70 lb. (300N)
Minimum apparent breaking elongation	ASTM D 4632	30%
Maximum apparent opening size	ASTM D 4751	300 µm
Minimum permittivity	ASTM D 4491	1.35 s ⁻¹
SCHEDULE C TEST	METHOD	VALUE ^[1]
Minimum grab tensile strength	ASTM D 4632	180 lb. (800N)
Minimum puncture strength	ASTM D 4833	70 lb. (300N)
Minimum apparent breaking elongation	ASTM D 4632	15%
Maximum apparent opening size	ASTM D 4751	600 µm
Minimum permittivity	ASTM D 4491	1.00 s ⁻¹ .

^[1] All numerical values represent minimum/maximum average roll values. Average test results from all rolls in a lot must conform to the tabulated values.

- (2) Do not use slit film woven fabric for this work.
- (3) For quantities over 2000 square yards (2000 m²), furnish to the engineer, at least 10 days before use in the work, a manufacturer's certified report of test or analysis that shows the geotextile fabric delivered conforms to the above requirements. Mark the delivered geotextile fabric to clearly identify it with the applicable test report furnished to the engineer. The engineer will obtain samples of fabric for testing from the job site for each 2000 square yards (2000 m²) or lesser portion used in the work.

645.2.5 Geotextile Fabric, Type SR (Subgrade Reinforcement)

- (1) Use the following test methods to confirm the values shown in the special provisions.

TEST	METHOD	VALUE ^[1]
Minimum tensile strength	ASTM D 4595	___ lb/in (N/m)
Minimum puncture strength	ASTM D 4833	___ lb. (N)
Maximum elongation at required strength	ASTM D 4595	___ %
Maximum apparent opening size	ASTM D 4751	No. ___ (µm)
Minimum permittivity	ASTM D 4491	_____ s ⁻¹

^[1] All numerical values represent minimum/maximum average roll values. Average test results from all rolls in a lot must conform to the tabulated values.

- (2) For quantities over 10,000 square yards (10 000 m²), furnish to the engineer, at least 10 days before use in the work, a manufacturer's certified report of test or analysis that shows the geotextile fabric delivered conforms to the above requirements. Mark the delivered geotextile fabric to clearly identify it with the applicable test report furnished to the engineer. The engineer will obtain samples of fabric for testing from the job site for each 10,000 square yards (10 000 m²) or lesser portion thereof used on this contract.

645.2.6 Geotextile Fabric, Type R (Riprap)

- (1) Use fabric conforming to the following physical properties:

TEST	METHOD	VALUE ^[1]
Minimum grab tensile strength	ASTM D 4632	205 lb. (900 N)
Minimum puncture strength	ASTM D 4833	80 lb. (350 N)
Minimum apparent breaking elongation	ASTM D 4632	20% (15%)
Maximum apparent opening size	ASTM D 4751	No. 30 (600 μm)
Minimum permittivity	ASTM D 4491	0.12 s ⁻¹

^[1] All numerical values represent minimum/maximum average roll values. Average test results from all rolls in a lot must conform to the tabulated values.

645.2.7 Geotextile Fabric, Type HR (Heavy Riprap)

- (1) Use fabric conforming to the following physical properties:

TEST	METHOD	VALUE ^[1]
Minimum grab tensile strength, lb	ASTM D 4632	305 (1350 N)
Minimum puncture strength, lb	ASTM D 4833	100 (150 N)
Minimum apparent breaking elongation, %	ASTM D 4632	20% (15%)
Maximum apparent opening size	ASTM D 4751	No. 30 (600 μm)
Minimum permittivity	ASTM D 4491	0.40, s ⁻¹

^[1] All numerical values represent minimum/maximum average roll values. Average test results from all rolls in a lot must conform to the tabulated values.

645.2.8 Geotextile Fabric, Type C (Modified SAS)

- (1) Use fabric conforming to the following physical properties:

TEST	METHOD	VALUE ^[1]
Grab tensile strength, lb	ASTM D 4632	205 lb. (900 N)
Puncture strength, lb	ASTM D 4833	70 lb. (300 N)
Maximum apparent opening size	ASTM D 4751	No. 50 (300 μm)
Minimum permittivity	ASTM D 4491	0.12 s ⁻¹

^[1] All numerical values represent minimum/maximum average roll values. Average test results from all rolls in a lot must conform to the tabulated values.

645.2.9 Geotextile Fabric, Type ES (Embankment Stabilization)

- (1) Use the following test methods to confirm the values required in the special provisions.

TEST	METHOD	VALUE ^[1]
Minimum tensile strength (machine direction)	ASTM D 4595	___ lb/in (N/m)
Tensile strength (cross direction)	ASTM D 4595	___ lb/in (N/m)
Maximum elongation at required strength	ASTM D 4595	___ %
Maximum apparent opening size	ASTM D 4751	No. ___ (μm)
Minimum permittivity	ASTM D 4491	___ s ⁻¹

^[1] All numerical values represent minimum/maximum average roll values. Average test results from all rolls in a lot must conform to the tabulated values.

- (2) Deliver to the engineer a sample of the geotextile material at least 15 days before incorporating it into the work. At the same time, furnish a sewn seam sample using the same geotextile fabric, thread, seam spacing and number, and overlap distance as are intended or required for use in the work.

- (3) Furnish to the engineer, at least 15 days before use in the work, a manufacturer's certified report of test or analysis that shows that the geotextile fabric delivered conforms to the above requirements. Mark the delivered geotextile fabric to clearly identify it with the applicable test report furnished to the engineer. The engineer will obtain samples of fabric for testing from the job site for each 10,000 square yard (10 000 m²) or lesser portion used on the contract.

645.3 Construction

645.3.1 Sewing

- (1) Sew all factory and field seams with a thread having the same or greater durability as the fabric material. Use a 401 stitch conforming to Federal Standard No. 751a for all seams. Ensure that all seams develop a tensile strength equal to or greater than 60 percent of the specified grab tensile strength of the fabric, unless specified otherwise.

645.3.2 Geotextile Fabric, Type SAS

- (1) Before placing the geotextile fabric, smooth, shape, and compact the subgrade to the required grade, section, and density. After placing the fabric on the subgrade area, the engineer will not allow traffic or construction equipment to travel directly on the fabric.
- (2) Roll the fabric out on the roadway and pull taut manually to remove wrinkles. Join separate pieces of fabric by overlapping or sewing. Place the fabric in the overlapped joints so it overlaps at least 18 inches (450 mm).
- (3) The engineer may require the use of weights or pins to prevent the wind from lifting the fabric.
- (4) After placing, do not expose the fabric longer than 48 hours before covering.
- (5) Place the base material over the fabric by back dumping with trucks and leveling with a crawler dozer. The contractor shall not use construction equipment that causes ruts deeper than 3 inches (75 mm). Fill all ruts with additional material. The engineer will not allow the contractor to smooth ruts without adding additional material. Cover damaged areas with a patch of fabric using a 3-foot (900 mm) overlap in all directions.

645.3.3 Geotextile Fabric, Type MS

- (1) Complete clearing operations before placing the fabric. Within the area being covered by fabric, cut stumps and sharp objects level with the ground surface. Do not remove sod, grass, and roots that extend beneath the ground surface. Carefully place the geotextile fabric on the ground using hand methods to avoid disturbing the existing root mat and vegetation. Roll the fabric out as smoothly as possible and pull taut manually to remove wrinkles. The engineer may require the use of weights or pins to prevent the wind from lifting the fabric. After placement, do not expose the fabric longer than 48 hours before covering. If visible defects exist, replace the defective section of fabric with a new defect-free section of fabric.
- (2) Place the geotextile fabric with the machine direction perpendicular to the roadway alignment. Sew all seams with 2 parallel stitch lines according to plan details. Space the parallel stitching no more than one inch (25 mm) apart. Place all seams perpendicular to the roadway alignment and facing upward. Ensure that all seams develop at least 80 percent of the specified cross direction tensile strength of the fabric, as determined by the same testing methods. Do not make butt splices between individual roll ends. One stitch line may not cross another stitch line. Repair all breaks or faults in any seam as the engineer directs.
- (3) Place the initial fill layer over the fabric to a depth not less than one-foot (300 mm) but not more than 2 feet (600 mm) by carefully end dumping and pushing on to the fabric. The contractor shall not use construction equipment that causes ruts deeper than 3 inches (75 mm) and does not excessively deform the marsh surface. The contractor shall not drive vehicles on the fabric. Complete the initial lift and install all instrumentation before placing any additional material. After placing the initial lift, place all subsequent lifts no deeper than one foot (300 mm). Do not begin any lift until completing the preceding lift and obtaining the engineer's approval. Conduct spreading operations so that no damage occurs to the fabric. Unless the engineer directs otherwise, place and spread lifts by expanding outward from the centerline of the fill. If fill placement damages the fabric, remove the fill material around the damaged area and the engineer will examine the damaged area to determine if the material requires replacement.

645.3.4 Geotextile Fabric, Type DF

- (1) Before placing the geotextile fabric in trench drains, construct the trench to the grades and dimensions the plans show or as the engineer directs. Remove protruding stones and other matter that might damage the geotextile fabric from the trench walls and base before placing the fabric. Place the geotextile fabric in the trench so it conforms to the trench walls and remains in proper position during drain construction and backfilling. The contractor may join separate pieces of fabric by overlapping or sewing. If overlapping, place the fabric in overlap joints of at least 18 inches (450 mm) in the direction of drain flow. Correct misaligned fabric as the engineer directs. The engineer will direct treatment of damaged fabric areas by one of the following methods:
 1. Place an additional section of fabric extending at least 24 inches (600 mm) beyond any point of the damaged area and position between the trench walls and the damaged fabric.
 2. Remove the section of fabric containing the damaged area and replace it with a new section of fabric.
- (2) After placing, do not expose the fabric longer than 48 hours before covering.
- (3) For applications other than trench drains, construct the surface on which placing the fabric to the grades and dimensions the plans show. Prepare the surface by removing or covering all objects that might damage the fabric. Carefully place the fabric to prevent damage and secure in position. Conduct backfilling or covering operations so that no damage or misalignment occurs to the fabric. Treat all fabric damage or misalignment as specified in the previous paragraph. After placement, do not expose the fabric longer than 48 hours before covering or backfilling.

645.3.5 Geotextile Fabric, Type SR

- (1) Before placing the fabric, smooth and shape the roadway to the required grade and section, and if the engineer requires, compact to the specified density. After placing the fabric on the earth grade, the contractor shall not allow traffic or construction equipment to travel on the fabric.
- (2) Roll out the fabric on the roadway and pull taut manually to remove wrinkles. Join parallel strips of fabric by overlapping or sewing. Sew seams as specified in [645.3.1](#), except ensure a tensile strength equal to or greater than 60 percent of the specified directional tensile strength of the fabric develops. Overlap the fabric in joints at least 24 inches (600 mm). Overlap butt splices between fabric rolls at least 36 inches (900 mm). The engineer may require the use of weights or pins to prevent the wind from lifting the fabric.
- (3) Cover all tears, holes, or rips in the fabric with a patch of fabric overlapping the defect 36 inches (900 mm) in all directions.
- (4) Cover all fabric within 72 hours of placement.
- (5) Place the backfill material in an initial lift of 12 inches (300 mm). Do not place subsequent lifts, in layers exceeding 12 inches (300 mm) in thickness. Spread each lift with a crawler type tractor and compact with suitable compaction equipment. The contractor shall not use construction equipment that causes ruts deeper than 4 inches (100 mm). The engineer will not allow turning movements for any hauling or spreading equipment on the fabric until at least 2 lifts of backfill, at least 18 inches (450 mm) deep, are placed and compacted. Do not begin subsequent lifts until spreading and compacting a distance of at least 1000 feet (300 m) of the previous lift. Maintain a 1000-foot (300 m) interval between subsequent lifts until completing each lift. If ruts greater than 4 inches (100 mm) develop during construction operations, the engineer may require the contractor to use lighter equipment, equipment with lower contact pressure, or smaller loads on existing equipment.
- (6) Fill all ruts in the surface of each lift of backfill with additional material. Do not smooth ruts without adding additional backfill.

645.3.6 Geotextile Fabric, Type R

- (1) Before placing the fabric, grade the area smooth and remove all stones, roots, sticks, or other matter that might prevent the fabric from completely contacting the soil.
- (2) Place the fabric loosely and lay it parallel to the direction of water movement. The engineer may require pinning or stapling to hold the geotextile in place. Join separate pieces of fabric by overlapping or sewing. Overlap the fabric in the joints at least 24 inches (600 mm) in the direction of flow. After placing, do not expose the fabric longer than 48 hours before covering.
- (3) Cover damaged areas with a patch of fabric that overlaps 3-feet (900 mm) in all directions.

- (4) Place riprap from the base of the slope upward. The engineer will determine the freefall height of riprap, but in no case should this height exceed one foot (300 mm).

645.3.7 Geotextile Fabric, Type HR

- (1) Place as specified in [645.3.6](#), except that the freefall height of riprap must not exceed 6 inches (150 mm).

645.3.8 Geotextile Fabric, Type C

- (1) Before placing geotextile fabric, construct and shape the grade to the required grade and section. After placing the fabric, the engineer will not allow traffic or construction equipment to travel on the fabric.
- (2) Roll out the fabric on the excavation and pull taut manually to remove wrinkles. Join separate pieces of fabric by overlapping or sewing. Overlap the fabric in joints at least 18 inches (450 mm). The engineer may require the use of weights or pins to prevent the wind lifting the fabric.
- (3) After placing, do not expose the fabric longer than 48 hours before covering.
- (4) Then place the specified backfill material over the fabric. The contractor shall not use construction equipment that causes ruts over 3 inches (75 mm) in depth. Fill all ruts with additional material and level to required grade. Do not smooth ruts without adding additional material.

645.3.9 Geotextile Fabric, Type ES

- (1) Before placing the geotextile fabric, construct the embankment to the required elevation and make the surface smooth and level. Place the fabric on the prepared surface to the limits the plans show with the machine direction of the fabric oriented in the direction the plans show. Roll out the fabric as smoothly as possible and pull taut manually to remove wrinkles. The engineer may require the use of weights or pins to prevent the wind lifting the fabric. After placing, do not expose the fabric longer than 48 hours before covering. If visible defects or damage to the fabric exists, remove the section containing the defect or damage and replace with a new section of defect-free fabric.
- (2) Sew all seams between fabric strips with 2 parallel stitch lines spaced no more than one inch (25 mm) apart according to the details the plans show. Orient all seams parallel to the roadway alignment and face upward. Sew all seams with a thread having the same or greater durability as the fabric material. Use a 401 stitch conforming to Federal Standard No. 751a for all seams. Ensure that all seams develop a tensile strength equal to or greater than 50 percent of the specified cross direction tensile strength of the fabric. Repair all sewing defects in any seam as the engineer directs. Do not use butt splices between individual roll ends.
- (3) Place the initial fill layer over any fabric layer to a depth not less than 8 inches (200 mm) or more than one foot (300 mm). Carefully end dump and push this lift on to the fabric. Perform spreading operations and use equipment in a manner that does not displace or damage the fabric. Do not make sharp turning movements while placing the initial lift over any individual fabric layer. The contractor shall not drive vehicles on the fabric. Complete the preceding lift before beginning the next lift. Place and compact additional lifts as specified in [section 207](#).
- (4) Unless specified otherwise, use the granular fill material, specified in the plans and special provisions, from at least 8 inches (200 mm) below to at least 8 inches (200 mm) above any single or multiple layer geotextile installation.

645.4 Measurement

- (1) The department will measure the Geotextile Fabric bid items by the square yard acceptably completed.

645.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
645.0100 - 0199	Geotextile Fabric (type)	SY

- (1) Payment for Geotextile Fabric Type SAS, Geotextile Fabric Type DF, and Geotextile Fabric Type SR, and Geotextile Fabric Type C is full compensation for providing, transporting, and installing the fabric.
- (2) Payment for Geotextile Fabric Type MS, Geotextile Fabric Type ES, Geotextile Fabric Type R, and Geotextile Fabric Type HR, and Geotextile Fabric Type C is full compensation for preparing the marsh area or foundation, and for providing, transporting, and installing the fabric.

SECTION 646 PAVEMENT MARKINGS

646.1 Description

- (1) This section describes furnishing and applying, or removing, pavement line markings.

646.2 Materials

646.2.1 General

- (1) The department approves pavement marking materials based on a combination of manufacturer or department performed tests and proven performance history. Provide the information specified for each individual material and additional material samples as the engineer requests.
- (2) Deliver paint and epoxy materials to the job site unopened, in manufacturer's containers legibly marked with the contents, color, batch number, date manufactured, and manufacturer's name and address. Do not use material more than one year old.

646.2.2 Paint

- (1) Furnish paint from the department's approved products list.
- (2) Have the manufacturer furnish a 2-quart (2 L) sample from each batch before shipping. Contact the department for submittal requirements and submit as the department directs.

646.2.3 Glass Beads

- (1) Furnish glass beads conforming to AASHTO M 247, except for gradation conform to the following:

SIEVE SIZE	PERCENT PASSING BY WEIGHT	
	FOR EPOXY	FOR PAINT
No. 20 (850 µm)	100	95-100
No. 30 (600 µm)	75-95	70-90
No. 40 (425 µm)	—	60-80
No. 50 (300 µm)	15-35	10-30
No. 80 (180 µm)	—	0-3
No. 100 (150 µm)	0-5	0-1

- (2) For each batch of beads actually furnished for the work, submit the following:
1. A certificate of compliance certifying that the beads conform to these specifications.
 2. A certified report of test or analysis indicating the results of gradation tests.
- (3) Furnish manufacturer treated beads with minimal surface scratching or scarring, and having at least 75 % true spheres. Use silane-coated beads with solvent-borne paint; use moisture resistant beads with water-borne paint. For other marking materials, use beads treated as the marking material r specifies.
- (4) Provide bulk containers or pallets of bags labeled with the bead type, net weight, lot or batch number, Wisconsin test number for that lot or batch, or blend date, and manufacturer's name and address.
- (5) Have the manufacturer furnish a one-quart (1 L) random sample representing each shipment before shipping. Contact the department for submittal requirements and submit as the department directs.

646.2.4 Epoxy

- (1) Furnish epoxy from the department's approved products list.
- (2) Submit a certified report of test or analysis indicating the results of laboratory tests made on the epoxy material furnished for the work. Identify the applicable manufacturer batch numbers in the submittal. Provide the following test results for each batch:

- Toxicity.
- Viscosity.
- Color.
- Weather resistance.
- Curing.
- Adhesion to concrete.
- Hardness.
- Abrasion resistance.
- Impact strength.
- Tensile strength.
- Compressive strength.
- Infrared spectra of each component.

646.2.5 Preformed Plastic

- (1) Furnish preformed plastic pavement marking material conforming to ITE standards.
- (2) Deliver preformed marking materials to the project in manufacturer's containers legibly marked with the contents, color, batch number, and manufacturer's name and address.

646.2.6 Raised Markers

- (1) Furnish raised pavement markers from the department's approved product list. Use the colors and configurations the plans show.

646.3 Construction

646.3.1 General

- (1) Perform the work under the pavement marking bid items distinguished as follows:

Pavement Marking: apply centerlines, no-passing barrier lines, lane lines, and edgelines.

Pavement Marking Channelizing: apply channelizing lines.

Pavement Marking Same Day: apply centerlines and no-passing barrier lines on the upper layer of pavements open to traffic. Complete the work on the same day the upper layer is placed, or on the same day existing markings are removed.

- (2) Apply markings at the locations and to the dimensions and tolerances the plans show, or as the engineer directs. Complete marking within specified time limits. Match the marking cycle at both project ends to be continuous from the existing marking to the new marking. Use the color the plans show. Ensure that lines have a uniform cross section and color. Reflectorize the lines with glass beads distributed uniformly throughout the specified thickness. Provide a sharp cutoff on both sides and ends of the line. Do not damage existing pavement markings that will remain in place.
- (3) Apply markings to a dry surface free from frost, except the contractor may apply epoxy to damp pavement. Remove dust, dirt, oil, grease, loose paint, gravel, debris, or other materials and contaminants that might prevent bonding to the pavement. Use equipment with a dust control system.
- (4) On contracts without the Locating No-Passing Zones bid item, reference the beginning and end of all existing no-passing barrier lines before pavement resurfacing that covers the pavement markings. After completing the resurfacing, accurately re-mark the no-passing barrier lines.
- (5) Apply permanent edgeline markings to the upper layer of new asphaltic pavement or surfacing within 7 days after completing mainline paving, but before a scheduled work suspension, unless the contract requires or the engineer directs or allows otherwise.
- (6) Apply permanent no-passing barrier lines and centerline markings to the upper layer of pavements open to traffic on the same day the layer is placed. Do not resume next-day construction operations until these markings are completed unless the engineer allows otherwise. As an option, the contractor may use temporary pavement markings to conform to these same-day requirements. Remove all temporary markings before placing permanent pavement markings.
- (7) Apply permanent pavement markings to new concrete pavements, or roads closed during construction, before opening those pavements to traffic, unless the engineer allows otherwise.
- (8) If removing existing markings before applying new markings, remove as specified in [646.3.4](#) exposing at least 85 % of the pavement surface. If installing new pavement marking without removing existing marking, retrace existing pavement markings or layout as the engineer directs.
- (9) On highways open to 2-way traffic, in addition to the marking vehicle, provide a leading vehicle and at least one trailing vehicle. Do not use flashing arrow panels to direct traffic to pass; otherwise equip each leading and trailing vehicle with the following:
 1. A slow-moving vehicle emblem.
 2. One or more flashing or revolving yellow lights showing to the front and rear.
 3. Signs to advise traffic of the wet line and number of vehicles in the marking train.
- (10) On one-way roadways, operate all marking train vehicles in the direction of traffic. Provide the same marking train as specified for 2-way traffic in [646.3.1\(9\)](#) except as follows:
 - A leading vehicle is not required, but use 2 trailing vehicles.
 - The contractor may use flashing arrow panels to direct traffic to pass.

- (11) Protect freshly applied markings until the line is dry or cured enough to prevent pickup under traffic. Place traffic cones on wet lines immediately behind the marking train or use a convoy of moving vehicles to keep traffic from crossing the wet line. Remove cones promptly after the line dries or cures.

646.3.2 Equipment

646.3.2.1 Paint Equipment

- (1) Use a marking vehicle with a paint tank that has calibrated dipsticks or other volume-measuring device. The equipment shall also have a device to register the daily-accumulated installed length for each gun.

646.3.2.2 Glass Bead Equipment

- (1) Use automatic, mechanical devices to apply glass beads to centerline, lane line, edgeline, and no-passing barrier line markings.

646.3.2.3 Epoxy Equipment

- (1) Use equipment that can spray both yellow and white material to produce uniform lines of the specified dimension. The equipment shall also be able to do the following:
 1. Apply lines both on the left and right sides, not necessarily simultaneously.
 2. Apply 2 lines simultaneously, with either line in a solid or intermittent pattern, in yellow or white.
- (2) The cycling mechanism used for applying lane skip lines shall produce uniform cycles. The equipment shall also have a device to register the daily-accumulated installed length for each gun.

646.3.3 Line Marking

646.3.3.1 Applying Paint

- (1) Apply paint as the manufacturer specifies. Do not apply below the minimum pavement temperature the manufacturer recommends. If the engineer requests, provide manufacturer specifications.
- (2) Apply paint uniformly across the line at or exceeding 17.6 gallons per mile (41.4 L/km) of continuous 4-inch (100 mm) line. Apply glass beads uniformly across the width of the line at or exceeding 7 pounds per gallon (0.84 kg/L) of paint.
- (3) If the engineer requests, provide calculations demonstrating that the paint application rate is consistent with the specified dimensions and that the bead application rate is consistent with the specified rate. If on any 0.5-mile (800 m) section the calculated application is less 90 % of that specified, remark that section.

646.3.3.2 Applying Epoxy

- (1) Apply epoxy as the manufacturer specifies. Do not apply below the minimum pavement temperature the manufacturer recommends. If the engineer requests, provide manufacturer specifications.
- (2) For both concrete and asphalt surfaces, remove surface contaminants by sweeping, air jetting, or water blasting immediately before applying the epoxy.
- (3) Do not apply epoxy over existing marking materials with less adherence than the epoxy. Prepare the surface of existing markings to ensure a permanent bond. If surface preparation techniques prove inadequate to ensure a permanent bond, the engineer may direct the contractor to remove the existing marking as specified in [646.3.4](#).
- (4) Prepare concrete surfaces using brush-off blasting to remove curing compound, laitance, or loosely adhering material. Conform to the "Steel Structure Painting Council Surface Preparation Specification Number 7" and expose at least 85 % of the concrete surface to be epoxied.
- (5) For the initial application, apply epoxy uniformly across the line at or exceeding the application rate for a continuous 4-inch line as follows:
 - 22.0 gallons per mile (51.7 L/km) for tined or diamond ground concrete, or for stone matrix asphalt pavement surfaces.
 - 17.6 gallons per mile (41.4 L/km) for all other pavement surfaces.
- (6) For subsequent applications, apply epoxy uniformly across the line at or exceeding 17.5 gallons per mile (41.2L/km) of continuous 4-inch (100 mm) line for all pavement surfaces.
- (7) Apply glass beads uniformly across the width of the line at or exceeding 22.5 pounds per gallon (2.7 kg/L) of epoxy.

- (8) If the engineer requests, provide calculations demonstrating that the epoxy application rate is consistent with the specified dimensions and that the bead application rate is consistent with the specified rate. If on any 0.5-mile (800 m) section the calculated application is less 90 % of that specified, remark that section.

646.3.3.3 Applying Preformed Plastic

- (1) Apply preformed plastic as the manufacturer specifies. If the engineer requests, provide manufacturer specifications.
- (3) For asphalt surfaces, apply the preformed plastic just before the final rolling and roll it into the surface.

646.3.3.4 Proving Period

- (1) The engineer will evaluate the performance of all paint, epoxy, and preformed plastic line markings periodically during a proving period. The proving period begins on the last day of the month, for all marking placed within each calendar month. For paint, the proving period is 180 days. For epoxy and preformed plastic, the proving period extends through the next full winter season or 180 days, whichever is longer. If weather or road surface conditions prevent the engineer from fully evaluating the marking at the specified end of the proving period, the engineer may extend the proving period.
- (2) The engineer will determine the percent failing during the proving period. The engineer will exclude failures due to abrasion loss at private entrances or within intersections. The department defines failure as discoloration, chipping, substrate exposure, or inadequate reflectivity. The department measures reflectivity with a LTL 2000 retroreflectometer in the direction of approaching traffic. Failing reflectivity, in millicandelas/lux/m², is defined as follows:

COLOR	PAINT	EPOXY	PREFORMED PLASTIC
White	<125	<200	<200
Yellow	<85	<150	<150

- (3) The engineer will assess marking sections defined as follows:
1. Each edgeline, lane line, or each combination of center and no-passing barrier lines, measured through any 2000 foot (600 m) length of highway, constitutes a separate section.
 2. All gore markings or turning lane markings at a single interchange or intersection constitute a separate section, regardless of length.
- (4) If more than 10 % of any marking section fails during the proving period, replace that section. Also, repair or replace all markings that, in the engineer's assessment, show evidence of improper construction. The engineer may not grant final acceptance of the project until the marking is replaced.
- (5) If the manufacturer provides a warranty beyond 180 days, provide the warranty and supplier information to the engineer.

646.3.4 Removing Pavement Markings

- (1) Remove pavement markings from locations the plans show or as the engineer directs. Do not damage, discolor, leave a detrimental residue on the surface, or paint over existing markings. Provide a dust control system and remove accumulated sand or other materials.
- (2) If blast cleaning within 10 feet (3 m) of a lane open to public traffic, remove all dust and other residue continuously while blast cleaning. Collect, haul, and dispose of dust or residue from removals. Repair damage caused by the contractor's removal operations.

646.3.5 Raised Pavement Markers

646.3.5.1 General

- (1) Under the Raised Pavement Markers bid item, install new markers as the plans show or the engineer directs.
- (2) Under the Raised Pavement Markers Replacement bid item, remove the existing marker as the manufacturer specifies and install a replacement marker as specified in [646.3.5.2](#).
- (3) Under the Raised Pavement Markers Replacement Lens bid item, remove the existing reflector lens and adhesive from the existing casting and install a new lens as the manufacturer specifies. If the casting is damaged in the contractor's removal operation, install a replacement marker as specified in [646.3.5.2](#).

646.3.5.2 Installing Raised Markers

- (1) Before beginning the work, locate automatic traffic recorder loops and other traffic control devices installed in the pavement. Do not damage these devices. Repair, to original installation specifications and operating condition, damage caused by contractor operations to these devices.
- (2) Prepare the surface and apply raised pavement markers as the casting and reflector manufacturers specify. If the engineer requests, provide manufacturer specifications.
- (3) Install the markers with the retroreflective lens perpendicular to a line parallel with the adjacent lane line. Install reflectors in the castings with no adhesive material on the reflective surface.
- (4) Center markers in lane-line gaps at the spacing the plans show or as the engineer directs. Do not install on cracked, checked, or spalled surfaces. Longitudinally relocate markers that fall on deteriorated pavement or at a joint as the engineer directs.
- (5) Place raised pavement markers toward traffic and align them with the lane line. Offset the edge of the marker 3 inches (75 mm) from the edge of pavement, a joint or crack, or a solid lane line. For 3 or more lanes, place markers transversely adjacent to each other.
- (6) Do not install markers in intersections or on bridge decks. When interrupted by an intersection or bridge deck, maintain the same spacing after the intersection or across the bridge deck.
- (7) Bond the markers to the pavement using a 2-part epoxy conforming to AASHTO M237, type IV. Use epoxy formulated to hard cure in 30-45 minutes at the field temperature. Mix the epoxy with an automatic mixer, to a uniform color before dispensing. Do not place epoxy when the pavement surface temperature or the ambient air temperature is less than 40 F (4 C).
- (8) Place a traffic cone over each installed marker until the epoxy is cured. If after 1-1/2 hours, a screwdriver or other pointed instrument can be pushed into the epoxy, do the following:
 1. Remove the marker and the epoxy.
 2. Clean and dry the sawed slot.
 3. Fill the sawed slot with an engineer-approved patch.
 4. Cut a new slot cut within 2 feet (600 mm) of the failed location and install a new marker.

646.3.5.3 Inspecting Raised Markers

- (1) The department will conduct an initial inspection of permanent raised reflective pavement markers following installation, but no later than November 30th. Repair or replace any installations the following spring that do not meet the initial inspection criteria.
- (2) The department will also conduct a final inspection of raised pavement marker installations within 15 calendar days after the end of a winter performance period. The 180-day winter performance period will begin on November 30th of the year the markers are installed. If less than 99% of the castings or less than 97% of the retroreflective lens are completely intact and functional following the winter performance period, repair or replace all of the damaged work to the original installation requirements within 30 calendar days. After passing the final performance inspection, or after satisfactory completion of the necessary corrections, the engineer will notify the contractor, in writing, of the date of the final performance inspection and release the contractor from further performance responsibility.

646.4 Measurement

- (1) For items measured by the linear foot of line, the department will calculate quantities as follows:
 1. For solid lines; by adding the linear feet of solid line measured end to end.
 2. For intermittent lines; by multiplying the specified length of the individual markings of the line by the number of markings in the intermittent line end to end.
- (2) The department will measure the Pavement Marking bid items by the linear foot of line acceptably completed.
- (3) The department will measure Removing Pavement Markings by the linear foot of 4-inch (100 mm) wide line acceptably completed.
- (4) The department will measure the Raised Pavement Markers bid items as each individual marker acceptably completed.

646.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
646.0100 - 0199	Pavement Marking (material) (width)	LF
646.0200 - 0299	Pavement Marking Channelizing (material) (width)	LF
646.0400 - 0499	Pavement Marking Same Day (material) (width)	LF
646.0600	Removing Pavement Markings	LF
646.0700	Raised Pavement Markers	EACH
646.0710	Raised Pavement Markers Replacement	EACH
646.0720	Raised Pavement Markers Replacement Lens	EACH

- (2) Payment for the Pavement Marking bid items under this section is full compensation for preparing the surface, including brush-off blasting of concrete; for providing all marking, including reflectorization with glass beads; for protecting marking until dry or cured; and for replacing marking improperly constructed or that fails during the proving period. Payment for paint and epoxy items also includes remarking if initially applied at less than 90 % of the specified rate.
- (3) Payment for the Pavement Marking Same Day bid items also includes removing all temporary pavement marking placed under the contractor option of same day pavement marking.
- (4) For the Pavement Marking Epoxy bid items, the department will pay separately for engineer-directed removals as Removing Pavement Markings if removal is required to prepare the surface for the initial marking application. Removals required to replace defective markings are incidental to the Pavement Marking Epoxy bid items.
- (5) Payment for Removing Pavement Markings is full compensation for removal, repairing associated damage, dust collection, and disposal of residue.
- (6) Payment for Raised Pavement Markers is full compensation for providing the markers, for preparing the surface; for repairing contractor damage to traffic control devices; and for replacing markers that fail during the winter performance period.
- (7) Payment for the Raised Pavement Markers Replacement bid items is full compensation for removing existing castings and lenses; for providing the replacement components; for replacing contractor damaged components; and for replacing components that fail during the winter performance period.

SECTION 647 SPECIAL PAVEMENT MARKINGS

647.1 Description

- (1) This section describes furnishing and applying, or removing, special pavement markings consisting of a combination of lines, arrows, symbols, and words.

647.2 Materials

- (1) Furnish pavement marking materials conforming to [646.2](#).

647.3 Construction

- (1) Apply pavement markings at the locations, and to the dimensions and tolerances the plans show, or as the engineer directs. Use the color the plans show. Conform to the applicable requirements of [646.3](#) modified as follows:
 1. Apply glass beads uniformly across the width of the line at or exceeding 18 pounds per gallon (2.2 kg/L) of paint or epoxy.
 2. Ensure that markings are straight or smoothly curved as the plans show.
 3. Protect arrow, symbol, and word markings with cones, barricades, or vehicles until dry or cured to a no-pickup condition.
 4. Each special pavement marking including stop lines, crosswalks, railroad crossings, arrows, symbols, and words constitutes a separate section subject to the engineer's evaluation at the end of the proving period.
- (2) Under the Pavement Marking Railroad Crossings bid items, apply the RXR symbol and 3 transverse stripes the plans show. On contracts that do not include pavement-marking work under section 646, also apply edgelines, lane lines, centerline, and no-passing barrier lines adjacent to the railroad crossing as the plans show.
- (3) Under the Pavement Marking Curb bid items, apply marking material to the vertical face and top of the curb.
- (3) Under the Pavement Marking Aerial Enforcement Bars bid items, the department will locate the markings. Give the engineer at least one week to coordinate with the State Patrol to provide the exact locations.

647.4 Measurement

- (1) The department will measure the each bid items under this section as each individual unit acceptably completed.
- (2) The department will measure the linear foot bid items under this section by the linear foot of line acceptably completed.
- (3) The department will measure the Pavement Marking Concrete Corrugated Median bid items by the square foot acceptably completed.
- (4) The department will measure Removing Pavement Markings Arrows, Removing Pavement Markings Symbols, and Removing Pavement Markings Words as each individual arrow, symbol, or word acceptably removed. The department will count removing an RXR symbol as 3 individual symbol removals.

647.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
647.0100 - 0149	Pavement Marking Railroad Crossings (material)	EACH
647.0150 - 0199	Pavement Marking Arrows (material) (type)	EACH
647.0200 - 0249	Pavement Marking Arrows Bike Lane (material)	EACH
647.0250 - 0299	Pavement Marking Symbols (material)	EACH
647.0300 - 0349	Pavement Marking Symbols Bike Lane (material)	EACH
647.0350 - 0399	Pavement Marking Words (material)	EACH
647.0400 - 0449	Pavement Marking Words Bike Lane (material)	EACH
647.0450 - 0499	Pavement Marking Curb (material)	LF
647.0500 - 0549	Pavement Marking Curb Ramp (material)	LF
647.0550 - 0599	Pavement Marking Stop Line (material) (width)	LF
647.0600 - 0649	Pavement Marking Island Nose (material)	EACH

647.0650 - 0699	Pavement Marking Parking Stall (material)	LF
647.0700 - 0749	Pavement Marking Diagonal (material) (width)	LF
647.0750 - 0799	Pavement Marking Cross Walk (material) (width)	LF
647.0800 - 0849	Pavement Marking Aerial Enforcement Bars (material) (width)	LF
647.0850 - 0899	Pavement Marking Concrete Corrugated Median (material)	SF
647.0955	Removing Pavement Marking Arrows	EACH
647.0960	Removing Pavement Marking Symbols	EACH
647.0965	Removing Pavement Marking Words	EACH

- (2) Payment for the Pavement Marking bid items is full compensation for preparing the surface, including brush-off blasting of concrete; for providing all marking, including reflectorization with glass beads; for protecting marking until dry or cured; and for replacing marking improperly constructed or that fails during the proving period. Payment for paint and epoxy items also includes remarking if initially applied at less than 90 % of the specified rate.
- (3) The department will pay separately for applying edgeline, lane line, centerline, and no-passing barrier lines adjacent to railroad crossings under the appropriate Pavement Markings (material) bid item as specified in [646.5](#). This work is incidental to the Pavement Marking Railroad Crossings bid items if the contract does not contain the appropriate Pavement Markings (material) bid items.
- (4) For the various epoxy bid items, the department will pay separately for engineer-directed removals as Removing Pavement Markings if removal is required to prepare the surface for the initial marking application. Removals required to replace defective markings are incidental to the epoxy bid items.
- (5) Payment for the Removing Pavement Markings bid items is full compensation for removing arrows, symbols, and words; and for repairing associated damage, dust collection, and disposal of residue. The department will pay for removing other special pavement markings under the Removing Pavement Marking as specified in [646.5](#).

SECTION 648 LOCATING NO-PASSING ZONES

648.1 Description

- (1) This section describes locating the termini of no-passing zones and spotting those termini on the pavement surface.

648.2 (Vacant)

648.3 Construction

648.3.1 Equipment

- (1) Use 2 vehicles that place the observer's eye 42 inches (1067 mm) above the roadway and a target 42 inches (1067 mm) above the roadway. Ensure that the target 42-inch (1067 mm) height point offers sharp cutoff when it disappears and appears.
- (2) Equip both vehicles with odometers that automatically subtract the distance traveled in reverse from the total forward distance measured before the reversal. Adjust the odometers to have an error of no more than 52 feet (16 m) in 2 miles (3.2 km).
- (3) Also, equip each vehicle with the following:
 - Slow moving vehicle emblems.
 - A sign with the message, "FREQUENT STOPS".
 - One or more flashing or revolving yellow lights.
 - Two-way communication equipment.

648.3.2 Locating No-Passing Zones

- (1) Locate the termini of all no-passing zones as the plans show or the contract specifies.
- (2) Spot the beginning and end of all no-passing zones by spray painting yellow T's and dots on the roadway. Use paint that will be readily visible for at least one year. Make T's one foot by one foot (300 mm x 300 mm) with at least a 2-inch (50 mm) wide line. Paint a 3 to 4 inch (75 to 100 mm) diameter dot on the centerline adjacent to the T stem.
- (3) Spot both ends of no-passing zones, to an accuracy of 52 feet (16 m), where the highway has inadequate sight distance. Conform to the sight distance requirements as follows:

POSTED SPEED LIMIT	SPOTTING	MINIMUM DISTANCE ^[1]
	SIGHT DISTANCE	BETWEEN ZONES
in mph (km/h)	in feet (m)	in feet (m)
25 - 30 (40 - 50)	528 (160)	528 (160)
35 - 40 (55 - 65)	686 (210)	528 (160)
45 - 50 (70 - 80)	845 (260)	660 (201)
55 (90)	see ^[2]	792 (240)

^[1] If the distance between 2 successive no-passing zones is less than the minimum distance between zones, connect the 2 zones.

^[2] The spotting sight distance is either 1108 feet (340 m) or 1373 feet (420 m) as the special provisions specify.

- (4) On horizontal curves, no part of the line-of-sight can extend outside the right-of-way, unless there is no possibility of sight restrictions developing within that line-of-sight.
- (5) Spot a no-passing zone wherever the sight distance is interrupted. If the no-passing zone is under 500 feet (150 m) long, extend the zone to 500 feet (150 m) by lengthening the zone at its beginning for each traffic direction.
- (6) Also, spot no-passing barrier lines as the plans show for the following:
 1. Approaches to railroad crossings.
 2. Bridges.
 3. Full width auxiliary lanes, such as a truck climbing, intersection bypass, or passing lanes

- (7) On state trunk highways, spot a 500 foot (150 m) no-passing barrier line at the following locations:
1. Approaches to intersections with a stop sign or traffic signal facing traffic on the highway being surveyed.
 2. Approaches to or departures from a divided highway.
 3. Approaches to an intersection with another state trunk highway.
 4. Other locations as the engineer directs.
- (8) Terminate intersection no-passing barrier lines at stop lines, marked crosswalks, stop signs, or signals; or if none of these features are present, at the theoretical stopping point.
- (9) If the contract specifies, also spot no-passing zones on planned detour routes. Unless the engineer directs otherwise, use criteria applicable to state trunk highways to locate all no-passing zones on county trunk highways and local roads on the detour route. Base the locations on posted detour speed limits.
- (10) Check the correctness of no-passing zones leading into and out of the project limits. Ensure that the minimum distance between zones and sight distance are correct.
- (11) Upon completing the work under this section, furnish the engineer 2 copies of an odometer log locating features to the 1/100 of a mile (0.01 km) for each road surveyed. Make all log points specific and readily identifiable. Include the following:
- The beginning and ending of each no-passing barrier line in both directions.
 - The speed criteria for each zone.
 - The location of all permanent landmarks.

648.4 Measurement

- (1) The department will measure Locating No-Passing Zones by the mile acceptably completed, measured as the actual centerline length of road surveyed and reported to the nearest 1/100 of a mile.

648.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid item:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
648.0100	Locating No-Passing Zones	MI

- (2) Payment is full compensation for all the work required under this section.

SECTION 649 TEMPORARY PAVEMENT MARKINGS

649.1 Description

- (1) This section describes furnishing and applying temporary pavement markings.

649.2 Materials

649.2.1 General

- (1) Unless a contract bid item or contract provision requires a specific material, the contractor may furnish any material specified here in [649.2](#). Provide sample materials for testing as the engineer requests.

649.2.2 Removable Tape

- (1) Furnish new 4-inch (100mm) tape with a pre-coated pressure-sensitive adhesive. Use tape that has demonstrated good performance in 6-month NTPEP tests for retroreflectivity, appearance, durability, removability, and residue. Use reflectorized tape where the plans show yellow or white marking. Use non-reflectorized tape where the plans show black marking.

649.2.3 Reflectorized Paint

- (1) Furnish commercially available solvent-borne or waterborne paint conforming to [646.2.2](#) and intended for marking traffic lanes on both concrete and asphalt highways. Reflectorize the paint using glass beads conforming to [646.2.3](#).

649.2.4 Reflectorized Tape

- (1) Use a commercially available 4-inch (100 mm) reflectorized pavement-marking tape that is readily visible when illuminated by headlights at night.

649.2.5 Raised Pavement Markers

- (1) Furnish raised pavement markers for temporary pavement marking from the department's approved product list. Use the colors and configurations the plans show. If installing at a new location, use new markers. If installing replacement markers, the contractor may install used markers in like-new condition.

649.3 Construction

649.3.1 General

- (1) Apply temporary pavement markings at the locations, and to the dimensions and tolerances the plans show, or as the engineer directs. Use the color the plans show. If applying markings over existing markings of a different color, completely cover the existing markings. If at any point a differently colored underlying marking shows through, re-apply the overlying marking.
- (2) Clean and dry the pavement surface before applying markings. Air blast or sweep milled asphaltic surfaces.
- (3) For pavements open to all traffic, apply markings to all intermediate pavement layers, including milled surfaces, on the same day the pavement is placed or milled unless the contract requires permanent same-day marking. If weather prevents marking, resume marking as soon as conditions allow.
- (4) If required to apply no passing zone temporary pavement marking, reference the beginning and end of all existing no-passing barrier lines before resurfacing. Accurately re-mark the temporary no-passing barrier lines after resurfacing.
- (5) Protect freshly applied painted markings until dry enough to prevent pickup under traffic. Replace all temporary pavement marking, including raised markers, that deteriorates or fails to adhere to the extent that the roadway is not adequately delineated.

649.3.2 Applying Temporary Markings

- (1) Apply paint at 13 gallons per mile (31 L/km), for a 4-inch (100 mm) line. Reflectorize with 4 pounds (0.7 kg) of glass beads per gallon (L) of paint applied to the wet line immediately after painting. Apply paint and glass beads at a uniform rate across the full width of the line. Use equipment conforming to [646.3.2](#).
- (2) Apply marking tape as the manufacturer recommends. Apply temporary raised markers using the surface preparation and installation procedures the manufacturer recommends.

649.3.3 Removing Temporary Marking

- (1) Remove Temporary Raised Pavement Markers and marking applied under the Temporary Pavement Marking Removable Tape bid items without damaging the pavement. The contractor need not remove other temporary markings except as follows:
 1. Work designated for removal under the Removing Pavement Markings bid items of section 646.
 2. Temporary marking placed as a contractor option under the same day marking requirements of section 646.
- (2) Collect, haul, and dispose of dust or residue from removals.

649.4 Measurement

- (1) The department will measure the linear foot bid items under this section by the linear foot of line acceptably completed. The department will calculate quantities as follows:
 1. For solid lines, by adding the linear feet of solid line measured end to end.
 2. For intermittent lines, by multiplying the specified length of the individual markings of the line by the number of markings in the intermittent line end to end.
- (2) The department will measure the each bid items under this section as each individual unit acceptably completed.

649.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
649.0100	Temporary Pavement Marking 4-Inch	LF
649.0200	Temporary Pavement Marking Reflective Paint 4-Inch	LF
649.0300	Temporary Pavement Marking Reflective Tape 4-Inch	LF
649.0400	Temporary Pavement Marking Removable Tape 4-Inch	LF
649.0700	Temporary Pavement Marking Channelizing 8-Inch	LF
649.0800	Temporary Pavement Marking Channelizing Removable Tape 8-Inch	LF
649.0900	Temporary Pavement Marking Stop Line 12-Inch	LF
649.1000	Temporary Pavement Marking Stop Line Removable Tape 12-Inch	LF
649.1100	Temporary Pavement Marking Stop Line 18-Inch	LF
649.1200	Temporary Pavement Marking Stop Line Removable Tape 18 Inch	LF
649.1300	Temporary Pavement Marking Stop Line 24-Inch	LF
649.1400	Temporary Pavement Marking Stop Line Removable Tape 24-Inch	LF
649.1500	Temporary Pavement Marking Diagonal 12-Inch	LF
649.1600	Temporary Pavement Marking Diagonal Removable Tape 12-Inch	LF
649.1700	Temporary Pavement Marking Arrows	EACH
649.1800	Temporary Pavement Marking Arrows Removable Tape	EACH
649.1900	Temporary Pavement Marking Words	EACH
649.2000	Temporary Pavement Marking Words Removable Tape	EACH
649.2100	Temporary Raised Pavement Markers	EACH

- (2) Payment is full compensation for preparing the surface; for providing all markings, including reflectorization; for protecting painted marking until dry; for replacing failed or deteriorated marking; and for removing markings applied under the section 646 contractor option for same-day marking.
- (3) Payment for the various Temporary Pavement Marking Removable Tape bid items and the Temporary Raised Pavement Markers bid item also includes marking removal, including dust and residue collection and disposal. The department will pay separately for contract required removals of other temporary pavement marking under the Removing Pavement Markings bid items as specified in [646.5](#) or [647.5](#).

SECTION 650 CONSTRUCTION STAKING

650.1 Description

- (1) This section describes the contractor performed construction staking required under individual contract bid items to establish the horizontal and vertical position for the following:

Storm sewer systems	Subgrade	Base
Curb, gutter, and curb & gutter	Pipe culverts	Structure layout
Concrete pavement	Concrete barrier	Resurfacing reference
Electrical installations	Initial layout	

650.2 (Vacant)

650.3 Construction

650.3.1 General

- (1) Department and contractor responsibilities for construction staking are specified in [105.6](#). Conform to [105.6](#) and the additional requirements specified here in [650.3](#) for the individual contractor-staking bid items the contract includes.
- (2) Obtain or calculate benchmark data, grades, and alignment from plan information. The engineer will furnish data for the horizontal and vertical control points, control point ties, horizontal alignments, profiles, and elevations. Reestablish, set additional, and maintain the horizontal and vertical control points and control point ties, as needed for bid items. Furnish, set, reference, and maintain all stakes and markings necessary to establish the alignment, location, benchmarks, elevations, and continuous profile-grades for all road and structure work as needed for bid items. Supervise and coordinate construction staking.
- (3) Check horizontal and vertical information including but not limited to alignments, locations, elevations, and dimensions, that either the plans show or the engineer provides, for compatibility with existing field conditions. Conduct similar compatibility checks and accuracy checks of horizontal and vertical positions either the department or the contractor establishes in the field.
- (4) Perform survey work consistent with third order, class II accuracy. Establish additional benchmarks and control points as necessary to support the method of operation, or as the engineer directs.
- (5) Maintain neat, orderly, and complete survey notes, drawings, and computations used in establishing the lines and grades. Make the survey notes and computations available to the engineer within 24 hours, upon request, as the work progresses.
- (6) Furnish all surveying equipment, stakes, flags, pins, lath, whiskers, and other materials necessary to perform this work, subject to the engineer's approval.

650.3.2 Storm Sewer System

- (1) Set and maintain construction stakes or marks as necessary to achieve the required accuracy and to support the method of operations. Locate all pipe, inlet, catch basin, manhole, and endwall construction stakes to within 0.02 feet (7 mm) of the true horizontal position, and establish the elevations to within 0.01 feet (3 mm) of the true vertical position. Determine that the final elevations of storm sewer pipe outfalls and inlets match the existing field elevations, and provide this information to the engineer at a mutually agreed upon date or least 14 calendar days before ordering inlets, catch basins, manholes, endwalls, and storm sewer pipe.

650.3.3 Subgrade

- (1) Set construction stakes or marks at a minimum 100-foot (40 m) intervals for rural sections and a minimum 50-foot (20 m) intervals for urban sections including additional stakes each cross-section to match the plan cross-section as necessary to achieve the required accuracy, and support the method of operations. Also, set and maintain stakes as necessary to establish horizontal and vertical position for intersecting road radii, auxiliary lanes, horizontal and vertical curves, and curve transitions. Locate stakes to within 0.25 feet (75 mm) of the true horizontal position, and establish the grade elevation to within 0.03 feet (10 mm) of the true vertical position.

650.3.4 Base

- (1) Set construction stakes or marks at 100-foot (40 m) intervals for rural sections and 50-foot (20 m) intervals for urban sections. Set and maintain sufficient stakes at each cross section to match plan cross-section, achieve the required accuracy, and to support the method of operations. Set and maintain stakes as necessary to establish horizontal and vertical position along intersecting road radii, auxiliary lanes, vertical and horizontal curves, and curve transitions. Locate stakes within 0.25 feet (75 mm) of the true horizontal position, and establish the grade elevation to within 0.03 feet (10 mm) of the true vertical position.

650.3.5 Curb, Gutter, and Curb & Gutter

- (1) Set construction stakes or marks at 50-foot (20 m) intervals, maximum. Set and maintain stakes as necessary to achieve the required accuracy and to support the method of operations. Set additional construction stakes as necessary to establish location and grade of curb, gutter, and curb & gutter, including points of change in alignment grade, along intersecting radii, and at the radius points of intersecting road radii. Locate stakes to within 0.02 feet (7 mm) of the true horizontal position, and establish the grade elevation to within 0.01 feet (3 mm) of the true vertical position.

650.3.6 Pipe Culverts

- (1) Set and maintain construction stakes or marks as necessary to achieve the required accuracy and to support the method of operations. Locate stakes for pipe culverts and appurtenant inlets and catch basins to within 0.25 feet (75 mm) of the true horizontal position, and establish the grade elevation to within 0.03 feet (10 mm) of the true vertical position. If installing pipe culverts at existing drainage ditches, verify the existing ditch location, elevations, and skew for a minimum of 150 feet (60 m) from pipe ends, and provide this information to the engineer at a mutually agreed upon date or 14 calendar days before ordering pipe culverts.

650.3.7 Structure Layout

- (1) Set construction stakes or marks on a line offset from the structure centerline or on a reference line, whichever is appropriate, for both roadway and substructure units. Establish the plan horizontal and vertical positions to the required accuracy. Also, set and maintain stakes and marks as necessary to support the method of operations. Locate stakes and marks to within 0.02 feet (7 mm) of the true horizontal position, and establish the grade elevation to within 0.01 feet (3 mm) of true vertical position. The department, unless the contract specifies otherwise, will compute deck grades with contractor-supplied girder elevation data.

650.3.8 Concrete Pavement

- (1) Set construction stakes or marks at 25-foot (8m) intervals. Set and maintain additional stakes as necessary to establish location and grade along intersecting road radii; and for auxiliary lanes, vertical curves, horizontal curves, and curve transitions according to the plans. Locate stakes to within 0.02 feet (7 mm) of the true horizontal position, and establish elevations to within 0.01 feet (3 mm) of the true vertical position. Set and maintain sufficient additional stakes at each cross-section to achieve the required accuracy and to support the method of operations.

650.3.9 Concrete Barrier

- (1) Set construction stakes or marks at 50-foot (20 m) intervals, maximum. Set and maintain additional stakes as necessary to establish location and grade of concrete barrier including point of change in grade, along intersecting radii, and at the radius point of intersecting radii to achieve the required accuracy and to support the method of operations. Locate stakes to within 0.02 feet (7 mm) of the true horizontal position, and establish the grade elevation to within 0.01 feet (3 mm) of true vertical position.

650.3.10 Resurfacing Reference

- (1) Set construction stakes for pulverized and re-laid pavement before beginning milling operations. Place construction stakes or pins for offsetting the roadway reference line at 100-foot (40 m) intervals, minimum, or as the engineer directs.
- (2) Place construction stakes or marks for all other types of resurfacing work at 300-foot (120 m) intervals, minimum, or as the engineer directs.
- (3) Set and maintain additional stakes as necessary to establish location and grade along intersecting road radii, auxiliary lanes, and curve transitions according to the plans.

650.3.11 Electrical Installations

- (1) Set and maintain construction stakes or marks as necessary to achieve the required accuracy and to support the method of operations. Locate stakes to within 0.02 feet (7 mm) of the true horizontal position, and to establish the grade elevation to within 0.01 feet (3 mm) of the true vertical position.

650.3.12 Initial Layout

- (1) Set and maintain construction stakes or marks to achieve the required accuracy and to support the method of operations. Check the department provided horizontal and vertical control information. Provide stakes to establish and maintain intermediate vertical and horizontal control for reference line alignment, side road alignments, radius points, and slopes on the ground, running bench level circuits and offsetting the horizontal roadway alignment. These stakes and markings constitute the field control used to govern and execute the work.
- (2) Verify the existing ground elevations as shown for all roadways on cross-section sheets for accuracy. Take and document a minimum of 3 shots per roadway section. Set and maintain slope stakes on each side of the road at each cross-section location the plans show. Stake additional clearing and grubbing, and marsh excavation limits at the locations where they vary from the slope stakes.
- (3) Document and provide complete descriptions and reference ties of the control points, alignment points, and benchmarks to the engineer to allow for quick reestablishment of the plan data at any time during construction and upon project completion.
- (4) Protect and reestablish all roadway alignment affected by the plan, or as the engineer directs.

650.4 Measurement

- (1) The department will measure the Construction Staking bid items for subgrade, base, concrete pavement, resurfacing reference, and initial layout by the linear foot acceptably completed, measured along each roadway centerline. The department will not measure construction staking for base underlying concrete pavement.
- (2) The department will measure Construction Staking Curb Gutter and Curb & Gutter by the linear foot acceptably completed, measured along the base of the curb face. The department will measure Construction Staking Concrete Barrier by the linear foot acceptably completed, measured along the base of the barrier. The department will not measure these bid items if abutting concrete pavement.
- (3) The department will measure Construction Staking Storm Sewer System as each individual inlet catch basin, manhole, and endwall acceptably completed.
- (4) The department will measure Construction Staking Pipe Culverts by each individual pipe culvert staked and acceptably completed.
- (5) The department will measure Construction Staking Structure Layout as a single lump sum unit for each structure acceptably completed. The department will measure Construction Staking Electrical Installations as a single lump sum unit for all electrical installations acceptably completed on each project.

650.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
650.4000	Construction Staking Storm Sewer System	EACH
650.4500	Construction Staking Subgrade	LF
650.5000	Construction Staking Base	LF
650.5500	Construction Staking Curb Gutter and Curb & Gutter	LF
650.6000	Construction Staking Pipe Culverts	EACH
650.6500	Construction Staking Structure Layout (structure)	LS
650.7000	Construction Staking Concrete Pavement	LF
650.7500	Construction Staking Concrete Barrier	LF
650.8000	Construction Staking Resurfacing Reference	LF
650.8500	Construction Staking Electrical Installations (project)	LS
650.9900	Construction Staking Initial Layout	LF

- (2) The department will not make final payment for any staking item until the contractor submits all survey notes and computations used to establish the required lines and grades to the engineer within 21 days of completing this work. The department will deduct from payments due the contractor for the additional costs specified in [105.6](#).
- (3) Payment for all the Construction Staking bid items is full compensation for locating and setting all construction stakes; for relocating and resetting damaged or missing construction stakes.
- (4) Payment for Construction Staking Initial Layout also includes resetting damaged or missing preliminary construction stakes; for protecting and reestablishing the alignment of all roadways; and for setting and checking slope stakes for all roadways.
- (5) Payment for Construction Staking Storm Sewer System also includes setting construction stakes as necessary for storm sewer pipe associated with each inlet, catch basin, manhole or endwall staked.
- (6) Payment for Construction Staking Pipe Culverts also includes setting construction stakes for appurtenant inlets and catch basins as necessary associated with each pipe culvert staked.

SECTION 651 GENERAL REQUIREMENTS FOR ELECTRICAL WORK

651.1 Description

- (1) This section describes general personnel qualifications, materials, construction methods, and testing requirements used to perform electrical work required in the contract under section 651 through section 678.

651.2 Materials

- (1) Furnish materials conforming to the Wisconsin State Electrical Code (WSEC), consisting of chapter comm. 16 of the WEC combined with the NEC. Do not consider the department a municipal electric department under the provisions of the WEC component of the WSEC.
- (2) For all materials not specified here, conform to the plans or the contract special provisions.
- (3) Within 10 days after notice of award of the contract, furnish a complete list of all material not on the department's approved products list, proposing to use, give the name and address of all manufacturers, along with catalog tear sheets showing catalog numbers, and specifications for each material. Furnish six copies of the list to the engineer. Do not order materials until the engineer approves the list. All material is subject to the engineer's inspection and approval before installation, and the contractor shall not make changes or substitutions in material or its installation without the engineer's written consent. The engineer will base material acceptance on inspection and testing of material delivered. Approval does not change contract requirements. If submitting a material as an alternate to the specified material, furnish all pertinent data necessary to show equal status with the approved material.
- (4) Furnish and install UL listed electrical materials or obtain the engineer's approval for materials that do not have a UL standard.
- (5) Furnish samples of materials proposing to use for testing at the engineer's request. Contractor shall be compensated if material is destroyed.
- (6) The department will list approved electrical construction products for the contractor to furnish, incorporate, and use, in a special provision included in the contract.
- (7) Return materials loaned from the district electrical units stock to that district electrical unit under the following terms:
 - Ensure that return materials are new.
 - Return materials to the electrical unit within 6 months of the date that they were picked up.
 - District electrical personnel will not release materials for contractor pick up until the district traffic engineer has a copy of the contractor's order forms for exact replacement materials.
 - Ensure that contractor-ordered replacement materials conform to the latest specifications and drawings used for new state replacement orders.
 - The department will not accept monetary reimbursement.

651.3 Construction

651.3.1 General

- (1) Perform all electrical work as specified in the applicable requirements of the WSEC, these specifications, the MUTCD, and the plan details.
- (2) If the contractor encounters stones, boulders, debris, or other material not normally contemplated in excavating, remove and dispose of the material as necessary and as incidental to completing the work.
- (3) If using trenching methods, place backfill in layers not exceeding 12 inches (300 mm) in depth and thoroughly compact each layer.
- (4) Dispose of surplus material from backfilling, excavating, and trenching as specified for disposing of surplus unsuitable material in [205.3.11](#). Restore all areas damaged or disturbed by the contractor's operations to conditions equal to those existing before the start of work.
- (5) Provide rust, corrosion, and anti-seize protection at all threaded assemblies by coating all mating surfaces with an approved compound provided on the department's approved products list. Do not use anti-seize material in aerosol cans. Paint or dip the anti-seize material on threads.
- (6) Unless specified otherwise in subsequent subsections, touch up mars and scratches on painted equipment with 2 coats of synthetic resin enamel, or with 2 coats of a zinc rich paint acceptable to the engineer, or as the engineer directs. This requirement applies whether using contractor-furnished or state-furnished equipment. Galvanized scratches shall be prepared as specified in [614.3.3](#).

- (7) Furnish and install, as incidental, all material needed to make the proposed system complete from the source of supply to the most remote unit if any piece of material is not designated in the contract as separate bid items. These materials may include but are not limited to wire nuts, grommets, tape, connectors, conduit lock nuts, split bolts, varnish, and putty.
- (8) Make the electrical connection between the equipment grounding conductor and any equipment-grounding electrode by the exothermic weld method.

651.3.2 Personnel Qualifications

- (1) Perform all electrical work using a journey worker electrician or an electrical apprentice under the onsite supervision of a journey worker electrician. Before performing electrical work, provide the documentation specified in [651.3.2\(3\)](#) to the engineer proving that the electricians performing the work have attained status as journey worker and apprentice electricians.
- (2) The department defines electrical work as electrical and related construction required under the contract, performed as specified in the standard specifications, contract special provisions, standard detail drawings, and plan details applicable to electrical construction.
- (3) Proof of qualification to do electrical journey worker level work shall be a certification of completion of a state apprenticeship program or a card issue by the department of commerce certifying the person as a journey wireman.

651.3.3 Testing

- (1) After installation and before final hookup, disconnect all loads whether buried or not, and test all grounded conductors, equipment grounding conductors, ungrounded conductors, and shielding contained in the cable with a megger. Ensure that the megger reads infinity during each of the following tests:
 - To ground.
 - Between each conductor.
 - Between each shield.
- (2) Furnish all equipment necessary to test the completed electrical installation. Test and demonstrate to the engineer's satisfaction that the following conditions exist:
 1. The circuits are properly connected, continuous, and free from short circuits and unspecified grounds.
 2. The connection conforms to the specified wiring layout, or the manufacturer's wiring layout or both.
 3. Each circuit operates.
- (3) The contractor shall request a signal inspection of the completed signal installation. This request shall be made to the project engineer at least three working days before the time of the requested inspection. DOT District Electric personnel will perform the inspection.
- (4) Approval for turn on will not be granted until the contractor corrects all discrepancies.
- (5) Replace cables containing conductors or shields, or both, that do not conform to this requirement as many times as necessary until they conform. Before the engineer accepts the replacement installation, repeat the testing procedure.
- (6) Operate the completed traffic signal installation for 72 hours consecutively, using the specified signal sequence and all special functions, such as preemption, as the plans show, or as the engineer approves.
- (7) The traffic signal installation is not complete until all the electrical work is complete and electrical systems work properly.
- (8) Operate the completed lighting installation for twenty consecutive nights without failure. Each component that fails shall be repaired or replaced and that component shall again be subject to the twenty-night proper working order test.
- (9) The lighting system is not complete until all electrical work is complete and inspected by the engineer, and all electrical systems work properly.

651.4 (Vacant)

651.5 Payment

- (1) The department will pay for the work specified in [section 651](#) separately under the various traffic signal, lighting, and ITS bid items, electrical work on rest areas and weigh stations, and miscellaneous electrical work under the contract.

SECTION 652 ELECTRICAL CONDUIT

652.1 Description

- (1) This section describes furnishing and installing rigid metallic or rigid nonmetallic conduit for traffic signals, lighting, and other electrical work, and rigid nonmetallic conduit for traffic signal detectors.

652.2 Materials

652.2.1 General

- (1) Use materials conforming to the class of material named and specified below.
- (2) Furnish electrical conduit with a UL label on each length delivered and used.
- (3) While the NEC conduit classification for rigid non metallic (RNC) includes PVC, HDPE and RTRC, under department specifications, RNC refers to PVC only.

652.2.2 Rigid Metallic Conduit

- (1) Use conduit and fittings conforming to ANSI C 80.1 for rigid metallic conduit, except that identification and inspection are not required.

652.2.3 Rigid Nonmetallic Conduit

- (1) Use PVC electrical conduit conforming to UL 651, for schedule 40 heavy wall type, or schedule 80 extra-heavy wall type.
- (2) If installing rigid nonmetallic conduit in an exposed location, use schedule 80 conduit.

652.2.4 Reinforced Thermosetting Resin Conduit

- (1) Use RTRC electrical conduit marked type AG conforming to UL 1684.
- (2) This conduit shall only be installed on the outside of structures.
- (3) RTRC conduit wall thickness, method or type of conduit coupling and types of fittings (terminations, expansion joints, etc.) shall be per manufacturers recommendation for external structure use.
- (4) Use manufactured bends and sweeps only. Do not make bends in the field.

652.2.5 Loop Detector Conduit

- (1) Furnish one inch (25 mm) schedule 40 PVC electrical conduit conforming to [652.2.3](#). Furnish fittings and attachments required to join and terminate conduits of the same material as the conduit except as the plans show and in the next paragraph, and designed specifically for the conduit furnished.
- (2) Use approved PVC terminal adaptor fittings to connect the cast iron T-condulet to PVC conduit. Furnish cast iron T-condulets made by an approved manufacturer. For the covers for cast iron condulets, use domed-type, wedge-nut style, steel cover, with neoprene gasket.

652.3 Construction

652.3.1 Installation of Conduit

652.3.1.1 General

- (1) Under the Conduit Special and Drain Duct bid items, the contractor may use either rigid metallic or rigid nonmetallic conduit. Under the Drain Duct bid items, furnish and install a duct for draining pull boxes.
- (2) Use conduit of the nominal inside diameter the plans show and make each run of conduit the distance the plans show or as the engineer directs. Install each run of conduit between adjacent access points using one size for its entire length. A run is the conduit from pull box to pull box, junction box to junction box, or pull box to junction box. If the engineer approves, the contractor may substitute a larger size of conduit than the contract shows for that run.
- (3) Furnish approved electrical conduit fittings
- (4) Pitch all conduit for drainage as the plans show. If unable to pitch PVC or RTRC conduit for draining, drain by drilling one 1/4-inch (6 mm) diameter hole in the underside of the conduit at each low point. Then place a drain sump under the drilled drainage hole as the conduit standard detail drawing shows.

- (5) A 12 AWG. XLP insulated, stranded, copper, 600 volt AC, pull wire shall be installed in each run of conduit, as laid, which is to receive future conductors, unless the contract provides for the installation of wire or cable. The wire shall be approximately 4 feet (1.2 m) longer than the run of conduit and shall be doubled back at least 2 feet (0.6 m) at each raceway access point. The pull wire shall be anchored at each access point in a manner acceptable to the project manager.
- (6) Ream and thread the ends of all rigid metallic conduit.
- (7) If installing wire or cable in rigid metallic conduit, install approved bushings on conduit before installing the wire or cable.
- (8) If not installing wire or cable in the rigid metallic conduit, then cap with engineer approved threaded protective caps. Lubricate the threads with an approved anti-seize compound.
- (9) Cap or plug all rigid nonmetallic conduit immediately after installation (unless the conduit terminates in a pull box) and keep capped or plugged until installing the wire or cable.
- (10) Install end bells on all rigid nonmetallic conduit raceway access points before installing wire or cable, or both. Ream non-metallic conduits to eliminate internal sharp edges before installing the end bells.
- (11) If required to connect nonmetallic conduit to rigid metallic conduit, use only UL listed adapter fittings.

652.3.1.2 Installing Underground

- (1) Unless the plans specify otherwise, install conduit in trenches excavated with vertical sides and of a depth and width sufficient to accommodate the outside diameter of the conduit couplings. Lay the conduit at the depth below grade specified the plans. Backfill the trench with select material passing a one-inch (25 mm) sieve.
- (2) Excavate trenches true to line and grade to provide the conduit uniform bearing throughout its length. Do not backfill the trench before inspecting the conduit. Carefully tamp the backfill in place as specified for placing backfill in layers in [651.3](#). Place at least 0.7 cubic feet (0.02 m³) of size No. 2 coarse aggregate, as specified in [501.2.5.4.4](#), directly under each drainage hole.
- (3) If cinders are present when laying rigid conduit, encase the conduit in at least 2 inches (50 mm) of concrete, or remove for at least 12 inches (300 mm) below the conduit and backfill the excavation with suitable material.
- (4) Zinc coat all field thread not covered by fittings, and all other areas of rigid metallic conduit that has the zinc coating removed or damaged by construction operations or otherwise, in a manner, and with an engineer-approved zinc rich paint. Thoroughly clean the damaged and adjacent areas before coating.

652.3.1.3 Installing Conduit Special Underground

- (1) Under the Conduit Special bid items, conform to [652.3.1.2](#) except install by jacking, boring, auguring, or other engineer-approved methods that do not disturb the existing overlying pavement, curb and gutter, or sidewalk. Use conduit suitable for the installation method used. Repair all pavement, curb and gutter, or sidewalk that the engineer determines disturbed or damaged by the installation conforming to State highway maintenance requirements and under the engineer's direction.

652.3.1.4 Installing on Structures

- (1) Unless specifically provided otherwise, do not leave openings in the structure for subsequent conduit placement.
- (2) If the plans include details showing methods and requirements for installation on structures, then conform to the plan details.
- (3) If embedding conduit in concrete hold it rigidly in place while pouring the concrete. Provide drainage for embedded raceways.
- (4) If required to attach conduit to structures, attach it with engineer-approved devices conforming to industry standards. Install approved expansion fittings where the conduit crosses an expansion joint in a structure. Install additional expansion fittings conforming to the NEC and adjust for the ambient temperature at the time of concrete pour.

652.3.1.5 Constructing Loop Detector Slots

- (1) Under the Loop Detector Slots bid item, construct slots in existing asphalt or concrete pavement for loop detector conduit, as the plans show or the engineer directs.

- (2) Construct by sawing the full width and depth of the slot, or by sawing both edges of the slot full depth and removing the remainder by chipping, or other engineer approved methods. Clean the slots with jets of water and compressed air; remove all dirt, dust, and debris; and thoroughly dry before installing the detector loop conduit. Remove and dispose of all surplus material.

652.3.1.6 Installing Loop Detector Conduit

- (1) Under the Conduit Loop Detector bid item, furnish and install loop detector conduit and related fittings as the plans show.
- (2) After installation, protect the loop detector conduit from any damage that could occur. Repair or replace damaged loop detector conduit at no expense to the department. The engineer will approve the replacement or repair method, and the resulting finished work.

652.3.2 Marking and Inspecting

- (1) Mark the location of each conduit as the plans specify.
- (2) After the conduit installation is complete, inspect each installed conduit before any wire is pulled. During this inspection, ensure that the conduit raceway is fully open for its entire length. Replace any conduit that the engineer determines crushed, damaged, or unsatisfactory, without at no expense to the department, before the department accepts the work. Furnishing all tools, equipment, and labor necessary to make the inspections is incidental to conduit installation.
- (3) At the discretion of the project engineer, at one randomly selected conduit arrow mark, the conduit shall be exposed. If the distance from the centerline of the exposed conduit to a plumb line projected down from the tip of the arrow mark, is more than six-inches (150 mm) then all arrow marked conduits shall be exposed. Any arrow mark, not meeting the six-inch (150 mm) limit shall be destroyed and conduit shall be remarked. All this work shall be incidental to the conduit installation.

652.4 Measurement

- (1) The department will measure the Conduit Rigid Metallic, Conduit Rigid Nonmetallic, Conduit Reinforced Thermosetting Resin, and Drain Duct bid items by the linear foot acceptably completed. The measured quantity will equal the linear feet of each size of each type, based on the distance along the centerline of the conduit from centerline of fitting to centerline of fitting, or end of conduit or between ends of conduit or duct.
- (2) The department will measure the Conduit Special bid items by the linear foot acceptably completed. The department will measure the extension of special conduit, to roadside pull boxes beyond the limits of existing pavement, curb and gutter, or sidewalk as Conduit Rigid Metallic or Conduit Rigid Nonmetallic.
- (3) The department will measure Conduit Loop Detector by the linear foot acceptably completed, measured around the loop and from the loop to the nearest pull box.
- (4) The department will measure Loop Detector Slots by the linear foot acceptably completed.

652.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
652.0100 - 0199	Conduit Rigid Metallic (size)	LF
652.0200 - 0399	Conduit Rigid Nonmetallic (schedule) (size)	LF
652.0400 - 0599	Conduit Reinforced Thermosetting Resin (size)	LF
652.0600 - 0699	Conduit Special (size)	LF
652.0700 - 0799	Drain Duct (size)	LF
652.0800	Conduit Loop Detector	LF
652.0900	Loop Detector Slots	LF

- (2) Payment for the Conduit Rigid Metallic, Conduit Rigid Nonmetallic, Conduit Reinforced Thermosetting Resin, and Conduit Special bid items is full compensation for providing the conduit, conduit bodies, and fittings; for providing all conduit hangers, clips, attachments, and fittings used to support conduit on structures; for pull wires or ropes; for expansion fittings and caps; for excavating, bedding, and backfilling, including any sand, concrete, or other required materials; for disposing of surplus materials; and for making inspections.

- (3) Payment for the Conduit Special bid items also includes repairing overlying pavement, curb and gutter, or sidewalk the contractor disturbs or damages.
- (4) Payment for the Drain Duct bid items is full compensation for providing the duct and fittings; for providing rodent screen and clamp; for excavating and backfilling; and for disposing of surplus materials.
- (5) Payment for Conduit Loop Detector is full compensation for providing all materials, including conduit, compacted backfill, surface sealer if required, pull wire if required, condulets, and conduit fittings.
- (6) Payment for Loop Detector Slots is full compensation for all sawing; for chipping if required; for removing and disposing of surplus material; and for cleaning the slot.
- (7) The department will not make additional payment for conduit larger than the contract size the contractor substitutes under [652.3.1.1](#).

SECTION 653 PULL BOXES AND JUNCTION BOXES

653.1 Description

- (1) This section describes furnishing and installing pull boxes and junction boxes.

653.2 Materials

653.2.1 Pull Boxes

- (1) Furnish pull boxes made of corrugated steel pipe conforming to the material requirements of [521.2.2](#) with annular corrugations.
- (2) Furnish manhole frame and solid lid conforming to [611.2](#). Use locking type covers in all pavement roadway locations. Install locking type covers on all 12-inch (300 mm) pull boxes.

653.2.2 Junction Boxes

- (1) Furnish junction boxes made by an approved cast iron manufacturer and having a hot dipped zinc coating. The covers shall be heavy duty, with a hot dip zinc coating, and equipped with watertight neoprene gasket and recessed, hex head, stainless steel cover bolts.
- (2) Furnish grounding lugs, mechanical connectors, that are UL listed and approved for copper wire. Use stainless steel for both inside and outside mechanical connections to the junction box. Provide engineer-approved protection that totally and permanently seals connections with a silicone or rubberized caulking compound. The grounding lug is not required in junction boxes when less than 50 volt AC is encountered.

653.3 Construction

- (1) Under the Pull Boxes Steel and Pull Boxes Steel Communications bid items, furnish and install pull boxes with manhole frames and solid lids. The contractor may extend pull boxes as the plan details show using the same material as the pull box. Saw extensions parallel to the annular ring and clamp to the pull box using a band manufactured for this purpose.
- (2) Also under the Pull Boxes Steel Communications bid items, use covers stamped with "WISDOT COMMUNICATIONS" as the plans show.
- (3) Under the Junction Boxes bid items, furnish and install junction boxes including grounding lugs with stainless steel mechanical connection and wiring if the plans show. Provide moisture drains in the bottom of all junction boxes.

653.4 Measurement

- (1) The department will measure the Pull Boxes Steel, Pull Boxes Steel Communications, and Junction Boxes bid items as each individual box acceptably completed.

653.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
653.0100 - 0150	Pull Boxes Steel (inch)	EACH
653.0190	Pull Boxes Steel Communications (inch)	EACH
653.0200 - 0299	Junction Boxes (size)	EACH

- (2) Payment for the Pull Boxes Steel and Pull Boxes Steel Communications bid items is full compensation for providing all materials, drain duct, and fittings, including the pipe, manhole frames, locking type covers, and bricks; for any pull box extensions the plans do not specify; for conduit extensions less than 10 feet long including fittings into a new or existing pull box; for grounding lugs and stainless steel mounting hardware; for coarse aggregate; and for all excavating, backfilling, and disposing of surplus material.
- (3) Payment for the Junction Boxes bid items is full compensation for providing all materials, drain duct and fittings, including the junction box with cover, grounding lugs and stainless steel mounting hardware, and wiring if required, supports, grout, and temporary asphalt; for any pavement cutting and grouting; and for disposing of surplus material.

SECTION 654 BASES

654.1 Description

- (1) This section describes constructing concrete bases, and concrete control cabinet bases at the locations the plans show.

654.2 Materials

654.2.1 Concrete Bases

- (1) Use schedule 40 PVC electrical conduit conforming to the electrical conduit specified in [section 652](#).
- (2) Furnish anchor rods, nuts, and washers conforming to ASTM A 449, or A 687 (grade 105). Use anchor rods having a minimum yield strength of 92,000 pounds per square inch (635 MPa) and a minimum elongation of 14 percent in 4 inches (100 mm). Hot-dip zinc coat the entire length of the anchor rods, and the nuts and washers conforming to AASHTO M 232. Thread at least 12 inches (300 mm) of the anchor rod. Use zinc coated nuts manufactured with sufficient allowance to allow nuts to run freely on the threads.
- (3) Furnish bar steel reinforcement conforming to [505.2](#).
- (4) Furnish grade A, A-FA, A-S, A-T, A-IS, or A-IP concrete conforming to [501.2](#).

654.2.2 Concrete Control Cabinet Bases

- (1) Conform to concrete bases specified in [654.2.1](#) and the following:
 - Use either mechanical wedge or epoxy type stainless steel anchors.
 - Use stainless steel bolts or studs, nuts, and washers.
 - Use anchors having pullout strength of 9000 pounds (40 kN).

654.3 Construction

- (1) Under the Concrete Bases bid items, construct concrete foundations, including necessary hardware, of the specified type.
- (2) Under the Concrete Control Cabinet Bases bid items, construct concrete bases for control cabinets, including necessary hardware, of the specified type.
- (3) Construct concrete bases and concrete control cabinet bases as specified in [section 501](#), and provide the surface finish specified in [502.3.7.2](#) and plan details. Inspect the forming and applicable reinforcement for concrete bases before pouring the concrete. Cure the bases for 7 days before installing any material on them.

654.4 Measurement

- (1) The department will measure the Concrete Bases and Concrete Control Cabinet Bases bid items as each individual base acceptably completed.

654.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
654.0100 - 0199	Concrete Bases (type)	EACH
654.0200 - 0299	Concrete Control Cabinet Bases (type)	EACH

- (2) Payment for the Concrete Bases bid items is full compensation for providing all materials including conduit, bushings, caps or plugs, or both, anchor rods, nuts, washers, grounding electrodes, exothermic welds, copper equipment grounding conductors, and bar steel reinforcement, if required, and concrete; and for excavating, backfilling, and disposing of surplus materials.
- (3) Payment for the Concrete Control Cabinet Bases bid items is full compensation for providing all materials including conduit, bushing, caps or plugs, or both, anchor rods, nuts, washers, grounding electrodes, exothermic welds, copper equipment grounding wires, bar steel reinforcement if required, and concrete; and for excavating, backfilling, and disposing of surplus materials.

SECTION 655 ELECTRICAL WIRING

655.1 Description

- (1) This section describes furnishing and installing electrical wire and cable for all traffic signal, highway/roadway lighting, and other underground installations.

655.2 Materials

655.2.1 Cable In Duct

- (1) Furnish conductors conforming to electrical wire, lighting specified in [655.2.6](#).
- (2) Furnish conductors enclosed in a coilable polyethylene duct, suitable for direct earth burial, that are manufactured from high density polyethylene conforming to the applicable requirements of ASTM D 1248, type III, grade P 34, class C, category 5.
- (3) Use UL listed Cable in Duct (CID) conforming to the NEC Article specifications for nonmetallic underground conduit with conductors, type NUCC.

655.2.2 Traffic Signal Cable

- (1) Furnish solid copper conductor traffic signal cables conforming to IMSA Specification Number 20-1. Provide wire size and number of conductors as the plans show.
- (2) For wiring that extends from the terminal strip in each signal head to the mounting base, use an IMSA, 20-1 cable, 14 AWG 4, 5, or 7 conductor as required.

655.2.3 Type UF Cable

- (1) Furnish type UF cable with ground including the number and size of conductors as the plans show. Use cable conforming to ANSI/UL 493.

655.2.4 Communication Cable

- (1) Furnish communication cable conforming to IMSA Specification 20-6. Use 6 pairs of 18 AWG in each cable. Twist conductors 12 turns per foot by the individual pair.

655.2.5 Grounded Conductor and Equipment Grounding Conductor, Traffic Signals

- (1) For the grounded conductor, use white insulation. For the equipment grounding conductor, use green insulation or green insulation with a yellow tracer applied by thermoset method.
- (2) Furnish 10 AWG or 8 AWG, or both, XLP, USE rated, 600 volt AC, single conductor, stranded copper for conductors.

655.2.6 Electrical Wire, Lighting

- (1) Furnish only single conductor, stranded copper, XLP insulated, USE rated and sized as the plans show for underground cable network conductors. Plans may specify a multi conductor cable rated for those applications, I.E. Type UF, etc.
- (2) Furnish 12 AWG unless sized otherwise in plans, XLP insulated, USE rated, single conductor, stranded copper, unless sized otherwise as the plans show for conductors from the underground cable network to luminaires.
- (3) Identify insulated conductors by covering the insulation surface with a tough, strongly adhered color coating conforming to Method I, or by surface printing conforming to Method III of IPCEA (Insulated Power Cable Engineers Association)-NEMA Standard S-19-81. Do not use white coatings on ungrounded conductors.
- (4) On 4 AWG conductor or larger, when color coding is necessary, the contractor shall do so per NEC. On 6 AWG conductor or smaller, use the insulation color as the plans show and furnish conforming to industry standards and the NEC.
- (5) Color code both tails of all ungrounded circuit conductors at splices and fuse holders as the plans show. If using tape to identify circuits, half-lap the tape for 2-inches (50 mm) or more using engineer-approved colored tape. The contractor may use stamped brass circuit identification tags instead of tape.
- (6) When there is more than one circuit, bundle the circuit conductors with nylon cable ties or approved electrical tape at all access points. At each hand-hole, identify the line side of each circuit with a tape colored as the plan specifies.

655.2.7 Loop Detector Lead In Cable

- (1) Furnish shielded, 14 AWG, 2 conductor, polyethylene insulated, with 16 AWG drain wire, conforming to IMSA Specification Number 50-2 for loop detector lead-in cable.

655.2.8 Loop Detector Wire

- (1) Furnish 12 AWG, XLP insulated, USE rated, single conductor, stranded copper for loop detector wire.

655.3 Construction

655.3.1 General

- (1) Do not splice underground in pull boxes or conduit, except that the contractor may splice underground loop detector lead-in cable to loop wire. Do not leave wire or cable ends uncovered or submerged in water. If the engineer observes this condition, the engineer may reject the entire length of cable or wire. Make all electrical connections and splices with approved pressure or compression type fittings.
- (2) Cover tape with a liberal coating of an electrical varnish or sealant providing flexible protection from oil, moisture, and corrosion. Obtain the engineer's approval of this electrical coating before using. Make electrical connections in the traffic signal base with spring wound wire nuts, insulated with a soft flexible covering or as detailed on the plans. Extend wire for termination 18 inches (450 mm) beyond the pole or traffic signal standard access point. Provide 60 inches (1500 mm) of cable wire to be pulled into cabinets and left for terminations.
- (3) For all cables entering each pull box, except loop detector lead in cables, provide an extra loop, approximately 6 feet (1.8 m) in length, to remain in each pull box. This loop of cable is in addition to the amount needed to reach from the entrance conduit raceway end to the opening in the exiting conduit raceway.
- (4) Install conductors in continuous lengths without splices from termination to termination. The contractor may splice only at hand-holes in the bases of the traffic signal standards or poles. At locations where no transformer bases exist, splice at the hand-holes in poles.

655.3.2 Cable In Duct

- (1) Under the Cable In Duct bid items, furnish and install underground cable in duct of the specified quantity and wire size of conductors.
- (2) Locate the cable as the plans show. Locate underground cable to preclude damage resulting from other construction operations.
- (3) Install cable in duct at least 30 inches (760 mm) below the finished grade or within the protection of conduit as the plans show. Should physical conditions at the cable location preclude placing to this depth, the contractor may modify the depth requirement as the WSEC allows. Place the cable in rigid steel conduit conforming to [652.2.2](#) for metallic conduit.
- (4) Set the underground cable in duct assembly 3 feet (900 mm) above the top of each light base or finished grade. Cap or seal the duct until completion of the electrical connections.
- (5) Continue the polyethylene duct to within 6 inches (150 mm) of a terminal connection.
- (6) If the size of the cable in duct prevents insertion through the conduit in a concrete base, the contractor may cut the duct off the assembly to allow for wire installation. In this case, after placing the wire, ensure at least one foot (300 mm) of intact duct remains in the conduit to protect the wires at the conduit entrance.
- (7) It is the intent of this specification that the cable duct will form a usable raceway as well as protection for the cable. Unreel the cable in duct, do not take off the side of the reel. Install the duct so it is free of kinks, sharp radii, and unnecessary wiggles. At the engineer's request, demonstrate free movement of the conductors within the duct after installation, and demonstrate the easy removal and replacement of the conductors within the duct.
- (8) If installing cable in duct by plowing, use round duct free of kinks or constrictions while fed into the plowing mechanism. At the engineer's request, excavate the cable in duct to check for depth violations. Correct all depth variations as specified in [105.3.2](#). Do not splice the cable in duct; replace it to the previous termination point.
- (9) Before installing cable in duct by trenching, remove rocks, stones, and concrete chunks from the trench, and place a layer of granular fill, free of damaging materials around the duct, 6 inches (150 mm) below and 12 inches (300 mm) above. Use select backfill material, with 100 percent passing a one-inch (25 mm) sieve.

- (10) Install insulated cables in continuous lengths without splices from terminal to terminal. Splice only in hand-holes of poles, transformer bases, sign bridge columns, or junction boxes as the plans show. Do not splice belowground or underground.

655.3.3 Traffic Signal Cable

- (1) Under the Traffic Signal Cable bid item, furnish and install multi-conductor cable for traffic signals and make all connections.
- (2) Numbers of conductors, in excess of those required are for future use.
- (3) Wrap back the conductors from multi-conductor cables that are spares along the multi-conductor cable and tape to the cable.
- (4) Effectively ground all spare or unused conductors in the signal control cabinet to the equipment grounding terminal strip.
- (5) Group and identify sets of conductors in signal cables, per signal phase, whether insulated with red, yellow, green, or other colors at each pertinent termination. Use conductors colored to match lens colors first or as shown in the plans.
- (6) Tag all traffic signal cables terminating in the signal control cabinet with waterproof tape and mark with indelible ink. Tape a plastic coated copy of the cable routing diagrams to the inside cabinet wall. Ensure markings indicate the geographical location. Indicate NW quadrant, S median, etc. The engineer will approve the method of identification.
- (7) Ensure the white grounded conductor, extending from the signal base to the terminal strip in the signal faces, is one foot (300 mm) longer than the ungrounded conductors. Locate the extra one foot (300 mm) of white grounded conductor in the cast base.
- (8) If mounting more than one signal head on a standard or pole, wire each head with a separate cable from the mounting base to the appropriate terminal strips.

655.3.4 Type UF Cable

- (1) Under the Cable Type UF bid items, furnish and install the underground cable network for highway lighting at traffic signal installations.
- (2) If installing lighting in conjunction with traffic signals, use type UF, 2 conductor with ground, solid or stranded copper conductor cable, sized as the plans show, from the traffic signal control cabinet to the pertinent light pole base or bases.
- (3) Strip the minimum length of jacket necessary to make terminations in a neat and technically proficient manner.

655.3.5 Communication Cable

- (1) Under the Communication Cable Plowed bid item, furnish communication cable for interconnecting traffic signals, and install the cable by plowing.
- (2) If installing communication cable by plowing, install at least 32 inches (800 mm) below finished grade.
- (3) Under the Communication Cable Trenched bid item, furnish communication cable for interconnecting traffic signals, construct a trench, and install the cable in the trench.
- (4) Install trenched communication cable as specified in [652.3.1.2](#) for underground installation except do not install less than 32 inches (800 mm) below finished grade.
- (5) During installation, prevent damage to the communication cable.
- (6) Under the Communication Cable Installed in Conduit bid item, furnish communication cable for interconnecting traffic signals, and install the cable in new or in existing, in place traffic signal conduit.
- (7) If installing communication cable in conduit, do not damage or disturb existing, in place cables within the conduit. Use wire lube on the full length of installed communication cable, if wire or cables exist in conduit.
- (8) Install all communication cable without splices between traffic signal control cabinets. Extend cable into each signal control cabinet for 6 feet (1.8 meters). Provide an extra loop, approximately 4 feet (1.2 m) in length, to remain in each pull box.

- (9) Test the communication cable following installation. Use a megger to perform ground resistance testing of all conductors including the shield, and conductor-to-conductor, including all individual conductors to the shield. Ensure that all conductor tests, including the shield, read infinity to ground, and from conductor to conductor and all individual conductors to the shield, read infinity. Replace cable not meeting the infinity test result at no expense to the department, whether one or many readings per cable are defective.

655.3.6 Grounded Conductors and Equipment Grounding Conductors for Traffic Signals

- (1) Connect the white 14 AWG wires in the signal head mounting base to the 10 AWG or 8 AWG white grounded conductor. Make the connection using a split bolt as the plans show. Extend the white grounded conductor from the grounded conductor bus in the traffic signal cabinet, from base to base around the intersection in a complete closed circuit.
- (2) Terminate all grounded conductors on a bus mounted in the cabinet and isolated from the cabinet and equipment grounding conductor. Terminate the grounded conductor bus at the grounding lug in the electrical service meter pedestal or meter socket.
- (3) Terminate all equipment grounding conductors on the equipment grounding bus that is isolated from the grounded conductor bus. Terminate the equipment grounding bus at the grounding lug in the electrical service meter breaker pedestal service disconnect, or meter socket, or terminate at the grounding lug of the breaker enclosure if the service is unmetred.
- (4) Make the equipment grounding connection in the signal pedestal base, or in a pole transformer base, with a pigtail and wire nut or split bolt to an equipment grounding conductor. Extend the equipment grounding conductor from the equipment grounding bus in the traffic signal cabinet, from base to base around the intersection in a complete closed circuit. Pull box shall be bonded with a jumper from the nearest signal base.
- (5) Under the Electrical Wire Traffic Signals bid items, furnish and install electrical wire for traffic signals and make all connections.
- (6) Make electrical connections in the traffic signal base with spring wound wire nuts, insulated with a soft flexible covering.
- (7) For the pigtail, use 10 AWG, bare copper wire or green XLP insulated, a minimum 16 inches (400 mm) in length. Attach one end of the pigtail to an approved mechanical connector, lug, and place the connector inside the base under the head of a 1/4" – 20 x 3/4" (M6 x 1.00 x 19 mm) hexagon head stainless steel cap screw tapped into the base.

655.3.7 Electrical Wiring for Lighting

- (1) Under the Electrical Wire Lighting bid items, furnish and install electrical wire of the specified conductor size for lighting, and make all connections.
- (2) Provide an 18 inch (450 mm) length of wire in each hand-hole for termination. For all wires entering each pull box, provide an extra loop, approximately 6 feet (1.8 m) in length, to remain in each pull box. This loop of wire is in addition to the amount needed to reach from the entrance conduit raceway end to the opening in the exiting conduit raceway.
- (3) Install conductors in continuous lengths without splices from terminal to terminal. Splice only at hand-holes or in the bases of the poles. Do not splice underground.
- (4) Install, in the ungrounded conductors at the hand-hole, an approved secondary in line 600 volt AC fuse assembly with a FNQ 5 ampere fuse or sized as the plans show. Install conductors in continuous lengths without splices from the luminaire to the underground feeder system or fuse assembly as appropriate. Use 2-pole waterproof fuse holders in 240 volt AC, 2-wire systems. Use single-pole fuse holders in 120 volt AC single-wire to ground systems. Provide voltage as the plans show. Install a sufficient length of 12 AWG, XLP wire in the pole shaft to allow easy removal and subsequent servicing of the fuse assembly through the pole hand-hole. Use an approved type of fuse holders from an approved manufacturer.

655.3.8 Loop Detector Lead In Cable

- (1) Under the Loop Detector Lead In Cable bid item, furnish and install loop detector lead in cable, splice loop and lead in cable together in the pull box, and connect the lead in cable to proper terminals in the control cabinet.
- (2) Install the loop detector lead in cable in electrical conduit furnished under other bid items. For lead in cable from the pull box to the control cabinet, install lead in cable in conduit either with or without other cables. Do not provide an extra length of loop lead in cable in pull boxes. For each loop, use a separate lead in cable to the control cabinet. Cut the drain wire flush with the lead in cable jacket.

- (3) Splice cables using cast in place splice kits from an approved manufacturer. Make splices as soon as possible after installing loop detector lead in cable.
- (4) If unable to splice to the lead in cable the day installing the wire, seal the cable ends with tar or electrical sealant to keep water out of the insulating jacket of the cable. If water does enter the insulating jacket, remove the cable and replace with new cable at no expense to the department.
- (5) A splice consists of a non-insulated butt connector, connecting one loop wire to one loop lead-in cable wire. Crimp and solder this connection with electrical multi-flux core. Crimp connect and solder the second 2 wires in the same manner. Half lap tape the solder connections with an approved rubber high voltage tape. Half lap tape each connection with an approved vinyl electrical tape and insulate connections from each other before placing in the splice kit. Coat each connection with an approved electrical varnish and allow the coating to dry. After drying, install the splice capsule conforming to the manufacturer's instructions.
- (6) If the engineer directs, open one randomly selected loop detector splice and inspect it for compliance with installation specifications. If the engineer determines the splice is non-compliant with the specifications, replace all loop detector splices on the project at no expense to the department.
- (7) After splicing the loop wire to the loop lead in cable, measure inductance, ground resistance, and wire resistance at the cabinet end of the lead in cable. Furnish a copy of the readings to the project engineer for evaluation.

655.3.9 Loop Detector Wire

- (1) Under the Loop Detector Wire bid item, furnish and install loop detector wire.
- (2) Install the loop detector wire in one-inch (25 mm) loop detector PVC conduit furnished under another bid item. The contractor may install loop wire before placing the conduit.
- (3) Do not provide an extra length of loop detector wire in the pull boxes.
- (4) Install the loop wire from the pull box at the side of the road, around the loop in the number of turns the plans show, and back to the pull box at the side of the road, in one continuous non-spliced length.
- (5) If unable to splice to the lead in cable the day installing the wire, seal the wire ends with tar or electrical sealant to keep water out of the insulating jacket of the wire. If water does get into the insulating jacket, remove the wire and replace with new wire at no expense to the department.
- (6) Measure the loop inductance, ground resistance, and loop wire resistance at the pull box end of the loop wire immediately after installation. Furnish a copy of the readings to the project engineer for evaluation.
- (7) Measure ground resistance using a megger. Replace loop wire not attaining a reading of infinity to ground.

655.4 Measurement

- (1) The department will measure the Cable In Duct bid items by the linear foot acceptably completed. This measurement includes conductors that had the duct cut away.
- (2) The department will measure the Cable Traffic Signal bid items, the Cable Type UF bid items, Communication Cable Plowed, Communication Cable Trenched, and Communication Cable Installed in Conduit by the linear foot acceptably completed.
- (3) The department will measure the Electrical Wire Traffic Signals and Electrical Wire Lighting bid items by the linear foot acceptably completed, measured separately for each conductor.
- (4) The department will measure Loop Detector Lead In Cable by the linear foot acceptably completed, measured from the splice with the loop lead in wire along the centerline of the conduit to its connection with terminals in the control cabinet.
- (5) The department will measure Loop Detector Wire by the linear foot acceptably completed, measured around the loop, including the number of turns and its lead to and from the splice with the lead in cable.

655.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
655.0100 - 0199	Cable In Duct (# of conductors) (AWG)	LF
655.0200 - 0299	Cable Traffic Signal (# of conductors) (AWG)	LF

655.0300 - 0399	Cable Type UF (# of conductors) (AWG)	LF
655.0400	Communication Cable Plowed	LF
655.0405	Communication Cable Trenched	LF
655.0410	Communication Cable Installed in Conduit	LF
655.0500 - 0599	Electrical Wire Traffic Signals (AWG)	LF
655.0600 - 0699	Electrical Wire Lighting (AWG)	LF
655.0700	Loop Detector Lead In Cable	LF
655.0800	Loop Detector Wire	LF

- (2) Payment for the Cable In Duct bid items is full compensation for providing all materials, including cables and duct; for excavating trenches; for placing cable in duct; for providing rigid steel conduit as needed; for backfilling; for restoring disturbed or damaged areas, including seeding and sodding; for making connections and testing installed cable system; and for disposing of surplus material.
- (3) Payment for the Cable Traffic Signal bid items, is full compensation for providing cable; for making all connections; for providing all connectors, including wire nuts; and for testing the circuits. The department will pay for wiring from the signal head terminal strip to the mounting base under the Cable Traffic Signal bid items appropriate for the conductor number and wire size the plans show.
- (4) Payment for the Cable Type UF bid items is full compensation for providing the cable; for making all connections; for providing all connectors, including wire nuts, splices, tape, insulating varnish, or sealant; and for testing the circuits.
- (5) Payment for Communication Cable Plowed is full compensation for providing all materials including cable; for plowing in the cable; for making all connections; for testing the installed cable; for restoring damaged or disturbed areas, including seeding or sodding; and for disposing of surplus material.
- (6) Payment for Communication Cable Trenched is full compensation for providing all materials including cable and backfill material; for constructing the trench, installing the cable in the trench, and backfilling; for making all connections; for testing the installed cable; for restoring disturbed or damaged areas, including seeding or sodding; and for disposal of surplus material.
- (7) Payment for Communication Cable Installed in Conduit is full compensation for providing all materials including cable; for installing the cable in existing, in place conduit; for making all connections; and for testing the installed cable.
- (8) Payment for the Electrical Wire Traffic Signals bid items is full compensation for providing electrical wire; for making all connections; for providing all connectors, including wire nuts and lugs; and for testing the circuits.
- (9) Payment for the Electrical Wire Lighting bid items is full compensation for providing electrical wire; for making all connections; for providing all connectors, including wire nuts, fuses, fuse holders, splices, tape, insulating varnish or sealant; and for testing the circuits. The department will pay for wiring from the underground feeder system to the luminaire under the Electrical Wire Lighting bid item appropriate for the wire size the plans show.
- (10) Payment for Loop Detector Lead In Cable is full compensation for providing the lead-in cable; for making necessary cabinet connections; and for furnishing splice kits and splicing to the loop detector wire.
- (11) Payment for Loop Detector Wire is full compensation for providing loop detector wire.
- (12) The department will not pay for relacing loop wire not attaining a reading of infinity to ground as required under [655.3.9](#).
- (13) Pedestrian push button wiring is incidental to the Pedestrian Push Buttons bid item under section 658.

SECTION 656 ELECTRICAL SERVICE

656.1 Description

- (1) This section describes furnishing and installing an electrical service, of the specified type.

656.2 Materials

656.2.1 General

- (1) Install the electrical service conforming to local utility requirements. Furnish the utility with a wiring affidavit certifying that the service conforms to the WSEC and then verbally inform the engineer that the utility received the wiring affidavit.
- (2) For grounding electrodes for the electrical service, use approved 5/8-inch (16 mm) diameter copper clad grounding electrodes. Furnish the number and length of grounding electrodes as required to install the service conforming to the WSEC and the local utility.
- (3) If required by the local utility, furnish and install a manual bypass meter socket. Obtain the local utility's approval of the manual bypass meter socket.
- (4) If an overhead service is required, furnish and install the riser, weatherhead, wiring, and all necessary fittings as incidental to the electrical service bid item.

656.2.2 Meter Socket Service

- (1) Furnish an approved service having a meter socket, NEMA 3R breaker enclosure, 22,000-AIC circuit breakers unless the local utility requires otherwise, grounding electrodes and connections, conduit and fittings, and all necessary conductors and equipment required by the WSEC and the utility for a service connection. Use circuit breakers with an amperage capacity of 50 A, unless specified otherwise in the contract.

656.2.3 Meter Breaker Pedestal Service

- (1) Furnish an approved service having a meter breaker pedestal, 22,000-AIC circuit breakers unless the local utility requires otherwise, grounding electrodes and connections, conduit and fittings, and all necessary conductors and equipment required by the WSEC and the utility for a service connection. Use circuit breakers with an amperage capacity 50 A, unless specified otherwise in the contract. When the meter breaker pedestal is energized, install an approved meter seal at all access points on the meter trough.

656.2.4 Unmetered Service

- (1) Furnish an approved service conforming to [656.2.2](#), except do not supply a meter socket.

656.2.5 Main Lugs Only Meter Pedestal Service

- (1) Furnish an approved service having grounding electrodes and connections, conduit and fittings, and all necessary conductors and equipment required by the WSEC and the utility for a service connection. Provide a lug amperage capacity, and the number of phases, and service voltage rating as the plans show.

656.2.6 Breaker Disconnect Box Service

- (1) Furnish a 100 A outside rated breaker box with space for 6 circuits, but no main breaker; to 50 A single circuit breaker (22, 000 AIC or larger as required by power companies), conduit fittings, grounding electrodes, and connections and all necessary conductors and equipment required to provide power to the cabinet.

656.3 Construction

656.3.1 General

- (1) Install the electrical service conforming to local utility requirements. Furnish the utility with a wiring affidavit, certifying that the service was installed conforming to the WSEC.
- (2) All above ground electrical service conduit and fittings shall be rigid metal conduit.

656.3.2 Service Lateral

- (1) The local utility shall furnish and install a 100 A, 120/240 volt AC, single phase, 3-wire underground electrical service lateral, unless specified otherwise in the contract documents. Arrange and assume responsibility for the timely installation of the service lateral by the utility. Terminate the lateral at a meter socket, meter breaker pedestal, a NEMA 3R Breaker Enclosure, or a main lugs only meter pedestal, as the plans show.

656.3.3 Meter Socket Service

- (1) If 2 or more grounding electrodes are required, space them at least 6 feet (1.8 m) apart and drive them near the termination point. Run a single unbroken length of stranded copper wire, appropriately sized per Code, from grounding electrode to grounding electrode (if more than one is required) and exothermically welded to each electrode. Then, connect to the meter socket and terminate at the grounding lug in the NEMA 3R Breaker Enclosure. Furnish and install connections and wiring to provide 120 volt AC power, or as the plans show, to the circuit breakers in the cabinets. If only one grounding electrode is required, exothermically weld the stranded copper wire to it and then connect to the grounding lug in the NEMA 3R Breaker Enclosure.
- (2) Furnish and install an appropriately sized equipment grounding conductor from the grounding lug in the NEMA 3R Breaker Enclosure to an equipment grounding bus mounted in the control cabinet.
- (3) If furnishing and installing intersection lighting along with the signal installation, feed lighting power to street lights from a separate circuit breaker. Use a common trip breaker for 240 volt AC installations. Size the breaker conforming to Code requirements, 15 A, minimum.

656.3.4 Meter Breaker Pedestal Service

- (1) If 2 or more grounding electrodes are required, space them 6 feet (1.8 m) apart and drive them outside the concrete base and near the electrical service meter breaker pedestal. Run a single unbroken length of stranded copper wire, appropriately sized per Code, from grounding electrode to grounding electrode (if more than one is required) and exothermically welded to each electrode. Then, terminate at the grounding lug in the meter breaker pedestal. Furnish and install connections and wiring to provide 120 volt AC power, or as the plans show, to the circuit breakers in the cabinet. If only one grounding electrode is required, exothermically weld the stranded copper wire to it and then connect to the grounding lug in the meter breaker pedestal.
- (2) Furnish and install an equipment grounding conductor, appropriately sized. Run the conductor from the grounding lug in the meter breaker pedestal to an equipment grounding bus mounted in the control cabinet.
- (3) If furnishing and installing intersection lighting along with the signal installation, feed lighting power to street lights from a separate circuit breaker. Use a common trip breaker for 240 volt AC installations. Size the breaker conforming to Code requirements, 15 amp, minimum.

656.3.5 Unmetered Service

- (1) Conform to [656.3.3](#), except no meter is required.

656.3.6 Main Lugs Only Meter Pedestal Service

- (1) Conform to [656.3.4](#).

656.3.7 Breaker Disconnect Box Service

- (1) Furnish connections and wiring to provide 120 volt AC power to the circuit breaker in the cabinet from the bus located within the breaker disconnect box.
- (2) Furnish connections and wiring to provide 120 volt AC power from the bus bar located within the meter breaker pedestal to the 50 amp single circuit breaker within the breaker disconnect box and then to the circuit breaker in the control cabinet.
- (3) Mount the breaker disconnect box to the cabinet as the plans show.

656.4 Measurement

- (1) The department will measure the Electrical Service bid items as a single lump sum for each service acceptably completed.

656.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
656.0100	Electrical Service Meter Socket (location)	LS
656.0200	Electrical Service Meter Breaker Pedestal (location)	LS
656.0300	Electrical Service Unmetered (location)	LS
656.0400	Electrical Service Main Lugs Only Meter Pedestal (location)	LS
656.0500	Electrical Service Breaker Disconnect Box (location)	LS

- (2) Payment for Electrical Service Meter Socket is full compensation for providing the meter socket; and for manual bypass meter socket if required, NEMA 3R breaker enclosure, conduit and fittings, circuit breakers, grounding electrodes and connections.
- (3) Payment for Electrical Service Meter Breaker Pedestal is full compensation for providing all materials including the meter breaker pedestal, manual bypass meter socket if required, conduit and fittings, circuit breakers, grounding electrodes and connections.
- (4) Payment for Electrical Service Unmetered is full compensation for providing all materials including the NEMA 3R breaker enclosure, conduit and fittings, circuit breakers, grounding electrodes and connections.
- (5) Payment for Electrical Service Main Lugs Only Meter Pedestal is full compensation for providing all materials including the main lugs only meter pedestal, disconnect if required, manual bypass meter socket if required, grounding electrodes and connections.
- (6) Payment for Electrical Service Breaker Disconnect Box is full compensation for providing all materials including the breaker box, circuit breakers, 10 AWG wire, grounding electrodes, cadwelding, conduit, fittings, wiring, connections, grounding electrodes and connections; for excavating, bedding, backfilling, and restoration of ground to original condition including any sand, concrete, or other required materials; for disposing of surplus materials.
- (7) The party or parties designated in the contract special provision as being responsible for the service lateral installation and energy costs shall pay for them. If the contract special provisions do not specify who is paying for the electrical service lateral installation and energy costs, then the ultimate owner of the electrical service shall bear both costs.

SECTION 657 POLES, ARMS, STANDARDS, AND BASES

657.1 Description

- (1) This section describes furnishing and installing poles, arms, standards, and bases for lighting and traffic signals.

657.2 Materials

657.2.1 Poles

- (1) Design support structures, consisting of poles and arms, conforming to AASHTO design and fabrication standards for structural supports for highway signs, luminaires, and traffic signals. Use a design life of 25 years. Design to withstand a 3 second gust wind speed of 90 mph (145 km/h). Do not use the methods of appendix C of those AASHTO standards.
- (2) Design support structures to the AASHTO fatigue category criteria as follows:
 1. Traffic signal support structures:
 - No fatigue analysis is required for type 1 structures.
 - Category II criteria for type 10 structures.
 - Category III criteria for type 2, 3, and 9 structures.
 2. Lighting support structures:
 - No fatigue analysis is required for type 4, 5, 6, 7, and 8 structures.
- (3) For structures requiring a fatigue analysis, use 45 mph (72 km/h) for truck-induced gusts.
- (4) Along with the materials list, submit a certificate of compliance certifying that poles as furnished, conform to the above structural performance requirements. Ensure that the certificate of compliance is on the manufacturer's letterhead stationery, signed by an authorized officer of the company, and notarized. Send a copy of the certificate and a copy of the pole shop drawings to the department electrical engineer. The department's review does not relieve the contractor of the responsibility for satisfactory results and is not considered an approval. Furnish poles from an approved manufacturer.
- (5) Furnish shop drawings as specified in [506.3.2](#), except submit 5 copies with the materials list. Ensure the drawings contain sufficient detail to allow satisfactory review and show the outside diameters of the pole at the butt, top, and splice locations the plans show. Show the width, depth, length, and thickness of all material, and list all pertinent ASTM specification designations and metal alloy designations together with the tensile strength of all metallic members.
- (6) After completing the manufacturing process, ensure that all shafts 35 feet (10.7 m) or less in length for lighting poles only, are round, of one-piece construction, and of the specified length.
- (7) Construct poles of materials having sufficient rigidity that, with all material installed and in place as the plans show, the centerline of the shaft appears vertical. Include dampers for lighting poles, type 5, 6, 7, in locations such as structure-mounted poles where vibrations may be more prevalent. However, if vibration becomes a concern after a pole has been installed, dampeners shall be installed at the project engineers discretion and they shall be paid for as extra work.
- (8) After welding and before zinc coating, clean the exterior surfaces of each steel pole free of all loose rust and mill scale, dirt, oil or grease, and other foreign substances.
- (9) Apply a zinc coating conforming to the process specified for steel sign bridges in [641.2.8](#). Ensure that the zinc coating is tight, free from rough areas or slag, and presents a uniform appearance.
- (10) After completing manufacturing, clean the exterior surfaces of each pole free of all loose scale, dirt, oil or grease, and other foreign substances.
- (11) The contractor may package poles in bundles containing a maximum of 4 poles.
- (12) Provide a reinforced hand hole measuring 4 inches by 6 inches (100 mm by 150 mm) as the plans show. Locate the hand hole 18 inches (450 mm) from the bottom of the pole base plate to the center of the door.
- (13) For the hand hole, include an access cover mounted to the pole by 2 1/4-20x3/4" (M6 x 1.00 x 19 mm) hex head stainless steel bolts.
- (14) Provide a grounding lug complete with mounting hardware as required, inside the pole as the plans show.

- (15) Provide access to the grounding lug from the hand hole. Mount the grounding lug by welding it directly opposite the hand hole on the inside wall of the pole.
- (16) Equip the top of the pole shaft with a removable, ventilated cap held securely in place by at least one hex head stainless steel set bolt, 1/4-20x3/4 inch screw (M6 x 1.00 x 19 mm).
- (17) Ensure that all castings are clean, smooth, and with all details well defined and true to pattern.
- (18) Attach base plates firmly to the pole shaft by welding or other approved method.
- (19) Indent print the aluminum pole type and the wall thickness in 2 locations on the side of the pole base plate, 180 degrees apart.
- (20) Indent print the steel poles in 2 locations on the side of the pole base plate, 180 degrees apart, after galvanizing.
- (21) Use aluminum shims.
- (22) Install identification plaques as the plans show.

657.2.2 Monotube Arms

- (1) Design monotube arms as specified for traffic signal support structures in [657.2.1\(1\)](#) through [657.2.1\(3\)](#).
- (2) Base the designs on the completed maximum loading configurations the standard detail drawings show. Along with the materials list, submit a certificate of compliance certifying that arms as furnished, conform to the above structural performance requirements. Ensure that the certificate of compliance is on the manufacturer's letterhead stationery, signed by an authorized officer of the company, and notarized. send a copy of the certificate and a copy of the monotube arm shop drawings to the department electrical engineer. This paper work is for informational review only, not for approval.
- (3) Furnish shop drawings conforming to [506.3.2](#). Show the width, depth, length, and thickness of the arms, and list ASTM designations.
- (4) List strength and grade specification ratings on the shop drawings.
- (5) Furnish monotube arms conforming to the following:
 - 1. Consist of zinc coated steel round or oval members.
 - 2. Have a mounting device welded to the pole end of the monotube arm that allows the attachment of the arm to a pole as the plans show.
 - 3. Have stiffeners or gussets if required between the arm tube and the arm mounting device to provide adequate strength to resist side loads.
 - 4. Have a clean, uniform natural finish. No paint or other corrosion preventive maintenance coating is required.
 - 5. Have the wiring raceway entrance through the upper mounting bracket.
- (6) After welding and before zinc coating, clean the exterior surfaces of each arm free of all loose rust and mill scale, dirt, oil or grease, and other foreign substances.
- (7) Apply zinc coating as specified for sign bridge components in [641.2.8](#). Ensure that the zinc coating is tight, free from rough areas or slag, and presents a uniform appearance.
- (8) After manufacturing is complete, clean the exterior surfaces of each pole free of all loose scale, dirt, oil or grease, and other foreign substances.

657.2.3 Luminaire Arms

- (1) Design luminaire arms to withstand all loads that the units are subject to in the field, including the loads applied by the materials attached to the structure. Design luminaire arms as specified for lighting structures in [657.2.1\(1\)](#). Along with the materials list, submit a certificate of compliance certifying that arms as furnished, conform to the above structural performance requirements. Ensure that the certificate of compliance is on the manufacturer's letterhead stationery, signed by an officer of the company and notarized. Send a copy of the certificate and a copy of the luminaire arm shop drawings to the department electrical engineer. This paper work is for informational review only, not for approval.
- (2) Furnish shop drawings conforming to [506.3.2](#). Include the dimensions of all members, list the ASTM alloy designation of aluminum members, and show weld details.
- (3) Furnish luminaire arms and mounting clamps made of extruded aluminum. Provide a mounting clamp welded to the pole end of the luminaire arm that is compatible to, and allows the attachment of, the luminaire arm to a round pole, dimensioned as the plans show. Install mounting clamps with stainless steel bolts, nuts, and washers. Use stainless steel bolts, nuts, and washers conforming to ASTM A 320.

- (4) Furnish a clean luminaire arm with a uniform natural aluminum finish. Do not paint or apply other corrosion preventive maintenance.

657.2.4 Traffic Signal Standards

657.2.4.1 General

- (1) Equip the top of the standards with a removable, ventilated cap, held securely in place by at least one hex head stainless steel bolt, 1/4-20x3/4 inch (M6 x 1.00 x 19 mm).

657.2.4.2 Aluminum

- (1) Furnish standards consisting of extruded, seamless aluminum alloy 6061-T6, manufactured conforming to ASTM B 241, or porthole extruded, aluminum alloy 6061-T6, manufactured conforming to ASTM B 429.
- (2) Furnish standards conforming to the following :
 1. Threaded on one end, tapered, and conforming to national pipe threading dimensions and normal practice.
 2. Inside dimension of 4 inches (100 mm).
 3. Outside dimension of 4-1/2 inch (115 mm).
 4. Schedule 80 aluminum pipe.

- (3) The manufacturer shall indent print the ASTM and alloy designations on the traffic signal standards using 1/4 inch (6 mm) size dies on the outside of the standard 2 inches (50 mm) above the threading.

657.2.5 Pedestal Bases

- (1) Furnish cast aluminum alloy pedestal bases designed as specified for traffic signal support structures in [657.2.1\(1\)](#) and selected from the department's approved products list. Ensure that castings are true to pattern in form and dimensions and free from pouring faults, sponginess, cracks, sharp edges, blow holes, and other defects in positions affecting strength and value for the service intended. Thread all casting collars to mate with the traffic signal standards furnished for the contract and specified in [657.2.2](#).
- (2) If the engineer requests, provide one randomly selected sample pedestal base per traffic signal location. The department will base acceptance of all pedestal bases at that traffic signal location on destructive tests of that sample base.
- (3) Along with the materials list, submit a certificate of compliance certifying that base as furnished, conform to the above structural performance requirements. Provide the certificate of compliance on the manufacturer's letterhead stationery, signed by an authorized officer of the company, and notarized.

657.2.6 Transformer Bases

- (1) Furnish cast aluminum alloy transformer bases designed as specified for traffic signal support structures in [657.2.1\(1\)](#) and selected from the department's approved products list. Ensure that castings are true to pattern in form and dimensions and free from pouring faults, sponginess, cracks, sharp edges, blow holes, and other defects in positions affecting strength and value for the service intended.
- (2) Along with the materials list, submit a certificate of compliance certifying that bases as furnished, conform to the above structural performance requirements. Provide the certificate of compliance on the manufacturer's letterhead stationery, signed by an authorized officer of the company, and notarized.
- (3) Use mounting washers conforming to the manufacturer's instructions.

657.3 Construction

657.3.1 Poles

- (1) Under the Poles bid items, furnish and install poles, ventilated pole caps, and all necessary miscellaneous hardware needed to complete the installation of the poles.
- (2) Install poles as specified in the plan details.
- (3) Before installation, clean each pole free of oil and foreign matter. Coat the following surfaces of aluminum poles with an approved corrosion preventative if required by the special provisions:
 1. The bottom 24 inches (600 mm) of the inside of the pole.
 2. Top and bottom of the pole base plate.
 3. Top and bottom of shims.

- (4) Follow the application procedure and drying time instructions provided by the corrosion preventative manufacturer.
- (5) After completing erection using normal pole shaft raking techniques, ensure the centerline of the shaft appears vertical.

657.3.2 Monotube Arms

- (1) Under the Monotube Arms bid items, furnish and install monotube arms for traffic signals.

657.3.3 Luminaire Arms

- (1) Under the Luminaire Arms bid items, furnish and install aluminum luminaire arms together with hardware and fittings as the plans show.
- (2) Securely clamped luminaire arms to the pole and rake so that the initial level of the luminaire tenon is plus 3 degrees.

657.3.4 Traffic Signal Standards

- (1) Under the Traffic Signal Standards bid items, furnish and install standards and ventilated polecaps for traffic signals.
- (2) Traffic signal standards shall be perpendicular to the bottom of a traffic signal pedestal base when installed tight in the top of the base, and the base has been leveled on its concrete foundation.
- (3) Thread standards into a traffic signal base straight and true, with no circular swing or sway.

657.3.5 Bases

- (1) Before installing, clean the mill scale, oil, and foreign material off transformer bases, traffic signal pedestal bases, and all other aluminum bases. Coat the bases with an approved corrosion preventative on the following surfaces, if the special provisions require:
 - Top and bottom surfaces of transformer bases.
 - The entire inside surface of transformer bases.
 - The bottom surface of pedestal bases.
 - The entire inside surface of pedestal bases.
 - All surfaces of aluminum shims.
 - Apply and dry conforming to the manufacturer's instructions.
- (2) Under the Pedestal Bases bid item, furnish and install department-approved pedestal bases for traffic signal standards, including necessary hardware.
- (3) Under the Transformer Bases bid items, furnish and install department-approved transformer bases for poles, including necessary hardware. Install transformer bases conforming to the manufacturer's instructions.

657.4 Measurement

- (1) The department will measure all the bid items under this section as each individual unit acceptably completed.

657.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
657.0100	Pedestal Bases	EACH
657.0200 - 0249	Transformer Bases Breakaway (size)	EACH
657.0250 - 0299	Transformer Bases Standard (size)	EACH
657.0300 - 0399	Poles (type)	EACH
657.0400 - 0499	Traffic Signal Standards Aluminum (length)	EACH
657.0500 - 0599	Monotube Arms (length)	EACH
657.0600 - 0699	Luminaire Arms Single Member (clamp size) (length)	EACH
657.0700 - 0799	Luminaire Arms Truss (type) (clamp size) (length)	EACH

- (2) Payment for Pedestal Bases is full compensation for providing the pedestal base, mechanical grounding connector and related mounting hardware; for leveling shims if required; and for preventing corrosion if required. The department will pay for sample bases, provided under [657.2.5](#), at the contract unit price for Pedestal Base.

- (3) Payment for the Transformer Bases bid items is full compensation for providing the transformer base, mechanical grounding connector, and related hardware; for leveling shims if required; and for preventing corrosion if required.
- (4) Payment for the Poles bid items is full compensation for providing all materials, including poles, all hardware and fittings necessary to install the pole; for corrosion prevention if required; for installing identification plaques if required; and for providing festoon outlets if required.
- (5) Payment for the Traffic Signal Standards Aluminum bid items is full compensation for providing the standards and pole cap.
- (6) Payment for the Monotube Arms bid items is full compensation for providing all materials, including all hardware, fittings, mounting devices, shims, and attachments necessary to completely install the arm.
- (7) Payment for the Luminaire Arms Single Member and Luminaire Arms Truss bid items is full compensation for providing all materials, including all hardware, fittings, mounting clamps, shims if required, and attachments necessary to completely install the luminaire arm.

SECTION 658 TRAFFIC SIGNALS

658.1 Description

- (1) This section describes furnishing and installing traffic signal faces and pedestrian signal faces at the locations the plans show.

658.2 Materials

658.2.1 Signal Mounting Hardware

- (1) Protect all brackets/clamps used for assembling and mounting traffic signal or pedestrian signal faces against atmospheric conditions. Use weather tight brackets/clamps. For all threaded signal face support hardware use 1-1/2 inch (38 mm) I.P.S.
- (2) Use an approved type of pole or standard vertical mounting brackets/clamps for signal faces from an approved manufacturer.
- (3) Use nipples of 1-1/2 (38mm) inside diameter, zinc coated, rigid metal conduit to complete the raceway from a pole or standard mounting bracket/clamp to the traffic or pedestrian signal face. Use nipples long enough to accommodate full depth threading into the head mounting lock nut in order to tighten the face, but that do not interfere with reflector closure. Thread the nipple into the mounting bracket/elbow until tight. Use approved pinnacle type hardware from an approved manufacturer to close the unused 1-1/2 inch (38 mm) openings in signal faces and bracket ends.
- (4) Use a 1-1/2 inch (38 mm) (I.P.S.) approved type of neoprene/rubber washers from an approved manufacturer to seal the top of a face, or the top of the top face in an array of face, to the upper mounting bracket to keep moisture out of the face.
- (5) For traffic signal face mounting lock nuts, use hex, zinc coated, malleable iron. ASME B16.14-1991 current for lock nut threading. Use 1/2-inch (13 mm) thick lock nuts that measure 2-1/2 inches (64 mm) outside flat to flat.
- (6) For rigid metallic zinc coated conduit nipples, use steel, 1-1/2 inch (38 mm), I.P.S. NPT, length as required.
- (7) When required, use corrosion resistant poly bracket shims.

658.2.2 Traffic Signal Faces

- (1) Furnish the housing, door, visor, and terminal strip in housing conforming to the current revised standard for Adjustable Face, Vehicle Traffic Control Signal Heads, issued by the Institute of Transportation Engineers except as modified below. Use only new materials.
- (2) Anchor terminal blocks in the signal faces to the compartment with threaded screws. Use 18 AWG wire terminal screws in the terminal blocks.
- (3) For vehicular signal indications use doors sized for 12 inch (300 mm) or 8-inch (200 mm) nominal diameter lenses.
- (4) Furnish vehicular traffic signal faces made of an approved polycarbonate resin. Polycarbonate signal face housing and door shall be manufactured from virgin material only. Reclaimed material is unacceptable. The signal face housing shall be federal highway yellow unless the contract specifies otherwise.
- (5) Manufacturers certification of signal face material as specified shall be included with the materials list. Manufacturers certification shall be signed and notarized by a duly authorized officer of the signal manufacturing company. This certificate shall accompany the materials list.

658.2.3 Backplates

- (1) Backplates shall be flat, dull black polycarbonate and shall project 5 inch (125 mm) beyond all sides of the signal housing and be securely mounted on the signal housing. Self tapping screws used to mount backplates to traffic signal faces shall be stainless steel.

658.2.4 Pedestrian Signal Faces

- (1) Furnish the housing, door, visor, and terminal strip in housing conforming to ITE standards for adjustable face vehicle traffic control signal heads, except as modified below. Use only new materials.
- (2) Furnish a single pedestrian signal face housing with a door sized for a nominal 12 inch square lens.

- (3) Anchor terminal block in the pedestrian signal face to the housing with threaded screws. Use 18 AWG wire terminal screws in the terminal block.
- (4) Furnish pedestrian signal face made of an approved polycarbonate resin. Polycarbonate pedestrian signal face housing and door shall be manufactured from virgin material only. Reclaimed material is unacceptable. The pedestrian signal face housing shall be federal highway yellow unless the contract specifies otherwise.
- (5) Manufacturers certification of pedestrian signal face material as specified shall be included with the materials list. Manufacturers certification shall be signed and notarized by a duly authorized officer of the signal manufacturing company. This certificate shall accompany the materials list.

658.2.5 Pedestrian Push Buttons

- (1) Furnish freeze proof type pedestrian push buttons made by an approved manufacturer. Band a standard R 10-3b series sign directly above each push button. Include a directional arrow or arrows on the sign as the plans show.

658.3 Construction

658.3.1 Signal Mounting Hardware

- (1) Under the Signal Mounting Hardware bid items, furnish and install mounting hardware necessary to attach pedestrian and traffic signal faces to standards, poles, and trombone arms.
- (2) Seal all voids between mounting brackets and poles by using silicon or rubberized caulking or similar material as the engineer approves.
- (3) Install approved sealing or closure pinnacles with neoprene/rubber washers in all topside holes of upper signal face head mounting brackets. Plug bottom holes on bottom mounting brackets with approved sealing or closure pinnacles.
- (4) If using 2 brackets with 2 mounting holes in each bracket, only use the upper hole of the top bracket to bolt the bracket to a pole or standard. Band the lower end of the upper bracket and the lower bracket to the pole or standard using 3/4 inch (19mm) wide, 0.025 inch (0.63 mm) thick, stainless steel bands. Use stainless steel clips.
- (5) Mount brackets banded to poles or standard so that the traffic signal assemblies are immovable. Mount all other traffic signal and pedestrian assemblies so that they are immovable.
- (6) Furnish stainless steel hex head cap screw 3/8 inch-24 NF (M10 x 1.25) mounting bolts. Drill and tap the pole or standard to match. Do not extend the bolt more than 1/4 inch (6 mm) through the wall, into the interior cavity of the pole or standard. Use a stainless steel flat washer sized to properly cover the bolt hole in the bracket and a stainless steel lock washer with each bolt.

658.3.2 Traffic Signal Faces

- (1) Under the Traffic Signal Face bid items, furnish and install traffic signal faces, including the installation of LED lenses. Install LED lenses per the manufacturers recommendations.
- (2) Use the cut away or tunnel type visors as the plans show.
- (3) Furnish the door face and visor in dull black unless the contract specifies otherwise.
- (4) Cover with hood or turn away all traffic signal faces from the view of the traveling public until the signal is accepted for use and activated.

658.3.3 Backplates

- (1) Furnish and install backplates on all signal faces as the plans show.

658.3.4 Pedestrian Signal Faces

- (1) Under the Pedestrian Signal Face bid item, furnish and install the pedestrian signal faces including the installation of LED lens. Install LED lens per the manufacturers recommendations.
- (2) Use the cut away or tunnel type visors as the plans show.
- (3) Furnish the door face and visor in dull black unless the contract specifies otherwise.
- (4) Cover or turn away all pedestrian signal faces from the view of the traveling public until the signal is accepted for use and activated.

658.3.5 Pedestrian Push Buttons

- (1) Under the Pedestrian Push Buttons bid item, furnish and install pedestrian push buttons.
- (2) Provide a 3/4-inch (19 mm) diameter push button mounting hole for wiring purposes in standards or poles. De-burr the holes after sawing and before installing the wire.
- (3) Plug the opening in the bottom of the pedestrian push button with a threaded pipe plug. Drill a 1/4-inch (6 mm) diameter hole in the plug for drainage purposes. Use IMSA 50-2 loop lead-in cable to wire the push button to the conductors in the base.

658.4 Measurement

- (1) The department will measure the Traffic Signal Face bid items, the Pedestrian Signal Face bid items, the Backplates bid items, and Pedestrian Push Buttons as each individual unit acceptably completed.
- (2) The department will measure the Signal Mounting Hardware bid items as a single lump sum unit for each intersection acceptably completed.

658.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
658.0100 - 0199	Traffic Signal Face (size) (vertical or horizontal)	EACH
658.0200 - 0290	Backplates Signal Face (# section) (size)	EACH
658.0300	Backplates Signal Face 12-8-8	EACH
658.0400 - 0499	Pedestrian Signal Face (inch)	EACH
658.0500	Pedestrian Push Buttons	EACH
658.0600	Signal Mounting Hardware (location)	LS

- (2) Payment for the Signal Mounting Hardware bid items is full compensation for providing all mounting hardware, including spacers, necessary to attach pedestrian and traffic signal faces to standards, poles, trombone, or monotube arms.
- (3) Payment for the Traffic Signal Face bid items is full compensation for providing signal faces including installation of L.E.D. lens.
- (4) Payment for the Backplates Signal Face bid items is full compensation for providing backplates and mounting screws.
- (5) Payment for the Pedestrian Signal Face bid items is full compensation for providing pedestrian signal faces including installation of L.E.D. lens.
- (6) Payment for Pedestrian Push Buttons is full compensation for providing pedestrian push buttons, pipe plugs, mounting hardware, signs, banding, and wiring.
- (7) The department will pay for wiring from the signal face terminal strip to the underground feeder cables at the top of the concrete base separately under the appropriate Cable Traffic Signal bid item as specified in [655.5](#).

SECTION 659 LIGHTING

659.1 Description

- (1) This section describes furnishing and installing highway, walkway, and other outdoor lighting.

659.2 Materials

659.2.1 General

- (1) Furnish luminaires with a housing cast or drawn from a nonferrous alloy and that is free of cracks and excessive porosity. Use nuts, screws, clips, washers, and attachment hardware fabricated from highly corrosion resistant alloys. Cadmium plating is not corrosion resistant. Paint luminaires utility gray unless the plans note otherwise.
- (2) Furnish specification grade luminaires that perform well within the various IES types specified. Furnish luminaires conforming to the optical performance that the design engineer judges to be necessary for the application.
- (3) Place an ANSI lamp type and wattage decal on the underside of the luminaire after mounting. Ensure that the decal is visible from the street.
- (4) Use luminaires made by an approved manufacturer.
- (5) Inside each luminaire housing place labels indicating wattage, voltage, and wiring diagram.
- (6) Furnish luminaires of the wattage the plans show.
- (7) Furnish luminaires of the type, voltage and wattage as the plans show.
- (8) For high-pressure sodium luminaires, use plug-in igniters.
- (9) Luminaires shall have a surge arrestor.
- (10) Furnish lamps as incidental to luminaires, rated for 24,000 hours of life or more from an approved manufacturer. Use clear high-pressure sodium vapor lamps.
- (11) If required, clamp the slipfitter securely to the luminaire arm, this allows a positive means of horizontal and vertical alignment of the luminaire in the field. Furnish a closed type optic assembly with permanently resilient gaskets, constructed to maintain an effective seal against moisture and other contaminants. Provide suitable screens at the slipfitter opening to deter insect nesting.
- (12) Position hinges and other fasteners for easy accessibility. Design hinges and fasteners to allow easy removal of the ballast, lamp, reflector, or glass refractor assembly from the luminaire, but provide for prevention of unintentional separation. Furnish refractor assembly fasteners that securely close the luminaire, and that upon quick visual inspection reveals whether or not the unit is latched properly.
- (13) Furnish a weather resistant reflector of sufficient strength and rigidity to prevent distortion during installation and maintenance.
- (14) Furnish lamp sockets attached to a high-grade porcelain base that completely encases the metal shell.
- (15) Incorporate a means to lock the lamp into the shell of the socket that resists lamp removal and ensures positive lamp contact.
- (16) Luminaires in a lighting system shall be energized by a single photocell actuating a contactor in a lighting control cabinet as plans show. Single-individual photocells for fixtures in a system are not acceptable unless specifically called for by the system designer. Do not use luminaires with caps, sockets, or openings that are not required.
- (17) Furnish and install circuit identification plaques and luminaire sequence decals suitable for outdoor construction, as the plans show

659.2.2 Luminaire Utility

- (1) Furnish un-fused luminaires, of the required wattage, high pressure sodium as specified, and that perform well within the defined limits of IES distribution as the plans show.
- (2) Furnish flat, clear tempered glass lenses with full cutoff.
- (3) Ballast shall be high power factor, magnetic regulator, lag type, copper windings and suited for operation at temperatures as low as minus 40 F (- 40 C). The ballast shall be mounted with quick-disconnect wiring on an interchangeable door assembly, internal trays are not an acceptable substitute. The quick-disconnect connections shall include an equipment grounding conductor. Grounding of the ballast door shall not depend on metal-to-metal contact.

- (4) The ballast type shall be:
- 70 Watt HPS – Mag Reg of a single voltage.
 - 100 Watt HPS – Mag Reg.
 - 150 Watt HPS – Mag Reg except use HPF reactor where multitap is specified.
 - 200 Watt HPS – Mag Reg.
 - 250 Watt HPS – Mag Reg.
 - 310 Watt HPS – Mag Reg.
 - 400 Watt HPS – Mag Reg.
 - 250 Watt MH - Autoreg.
- (5) Equip each luminaire with a leveling device that is visible from the roadway. Use a leveling device that indicates both longitudinally and transversely if the optical assembly is level and functions in temperatures as low as -30 F (- 34 C).
- (6) Furnish luminaire housings for 200 watt to 400 watt fixtures sized to the manufacturer's full roadway size. The contractor may furnish smaller luminaire housings for 100 watt to 150 watt fixtures.
- (7) Furnish variable socket settings to accommodate various IES output settings. IES Types 2 and 3 are minimal required settings.
- (8) Luminaires shall have a photometric distribution Type Medium, Cutoff, IES Type 3. The photometric distribution shall be created by means of multifaceted reflector.
- (9) Weight shall not exceed 40 lb. Effective Projected Area (EPA) shall not exceed 1.5 square feet. Luminaires shall be ovate in shape, and electrocoated gray in color.
- (10) Provide a slipfitter system that consists of a single clamp, 2-bolt system, with a selection of steps for selecting the rake of the luminaire. Construct the luminaire so that the lamp changing does not require tools.

659.2.3 Luminaire Underdeck

- (1) Furnish luminaires of the require wattage, high-pressure sodium with glass refractors and provisions in the sides and top for direct conduit entry. Locate and size luminaire fuses as the plans show.
- (2) Ballast shall be high power factor, magnetic regulator, lag type, copper windings and suited for operation at temperatures as low as – 40 F (- 40 C). If Mag Reg is not available in the specified wattage, then use a CWA or Auto Reg. Ballast.

659.2.4 Luminaire Sign Lighting

- (1) Furnish individually fused, mercury vapor, sign luminaires with a photometric performance suitable for spacing of up to 23 feet (7 m) for sign panels. Use deluxe mercury vapor lamps.
- (2) The engineer will evaluate photometric performance over a 20 foot (6.1 m) (horizontal) by 10 foot (3 m) (vertical) sign panel with a single luminaire centered on the sign, 4 feet (1.2 m) out and one foot (300 mm) down. On this panel, provide a maximum initial illuminance at any point of 45 foot-candles (480 lx); a ratio of illuminance, maximum to minimum, of 12:1 or less; and a ratio of illuminance, average to minimum, of 4:1 or less.
- (3) Use stainless steel perforated channels to support the luminaires for sign lighting. Use stainless steel fasteners and hardware to attach the sign lighting fixtures and their supports.
- (4) Ballast shall be high power factor, magnetic regulator, lag type, copper windings and suited for operation at temperatures as low as – 40 F (- 40 C). If Mag Reg is not available in the specified wattage, then use a CWA or Auto Reg. Ballast.

659.2.5 Luminaire High Mast Lighting

- (1) Furnish individually fused, high-pressure sodium, high mast luminaires with IES type 3 distribution or as the plans show. Use sharp cutoff type luminaires without prismatic refractors.
- (2) Furnish slipfitter mounted luminaires.
- (3) Use luminaires that provide lamp support near the end of the lamp envelope to relieve strain on the lamp and socket and to resist vibration.
- (4) Furnish luminaire optical assemblies capable of rotating 360 degrees against the fixed position of the slipfitter.

- (5) Ballast shall be high power factor, magnetic regulator, lag type, copper windings and suited for operation at temperatures as low as minus 40 F (- 40 C). If Mag Reg is not available in the specified wattage, then use a CWA or Auto Reg. Ballast.

659.2.6 Lighting Units, Walkways

- (1) Furnish IES Type 5 distribution luminaires or as the plans show.
- (2) Locate and size luminaire fuses as the plans show.
- (3) Furnish luminaires with self-leveling slipfitters to fit pedestal base standard tops or mounting tenons.
- (4) For refractors, furnish one-piece prismatic, injection-molded polycarbonate, with a symmetric light pattern, or as called for on the plans.
- (5) Furnish a modular design ballast assembly containing all electrical components including ballast, terminal block, socket, starter, and bracket. Use a fully encapsulated quick disconnect type starter. Ballast shall be high power factor, magnetic regulator, lag type, and suited for operation at temperatures as low as minus 40 F (- 40 C). If Mag Reg is not available in the specified wattage, then use a CWA or Auto Reg. Ballast.

659.3 Construction

659.3.1 General

- (1) Keep the luminaire lamps in their shipping cartons and protect against contamination until use.
- (2) Wear clean gloves when installing luminaire lamps.

659.3.2 Wiring and Fusing

- (1) Use 12 AWG, stranded copper, XLP insulated, single conductor, USE rated, 600 volt AC wire from the lighting branch circuit to luminaires, unless sized otherwise on the plans.
- (2) For fusing in hand-holes or junction boxes, use approved in-line 600 volt AC fuse assemblies from an approved manufacturer, with type FNQ fuses. If luminaires are double-fused in 240 volt AC 2-wire systems, or 480 volt AC 3-phase delta systems, furnish and install 2-pole fuse holders.
- (3) Individually fuse the luminaires at 5 amp, or as the plans show otherwise. Locate fusing at the pole hand-hole. Fuse walkway lighting units at 5 amp, in the hand-hole of the pole. Fuse underdeck lighting at 5 amp per each luminaire, located as the plans show. Fuse sign lighting at 20 amp per each ungrounded conductor, in the lower column hand-hole, in addition to the required fuses, sized as the plans show, in the luminaires.
- (4) For sign lighting and underdeck lighting, provide a separate equipment grounding conductor, equal in size to the ungrounded conductors, in all runs.
- (5) For hand-hole or junction box splices and fuse assemblies, provide a neatly trained loop of each conductor to facilitate removing each splice and each fuse assembly from the hand-hole or the junction box for servicing. Ground each hand-hole or junction box as the plans show.
- (6) If the plans show grounded neutral lighting systems, ground the neutral only as far as the hand-hole or the junction box. From the hand-hole or junction box to the luminaires, isolate the neutral, and separately bond metal parts to ground.
- (7) Connect the equipment grounding conductor to the grounding lug in each metal lighting pole and sign bridge column. If transformer bases are required, make the grounding connection to the transformer base.
- (8) Make the splices of lighting conductors in breakaway bases or in hand-holes electrically secure. Protect the splices with an approved vinyl plastic tape and insulate the splice equal to that of the rest of the conductor. If making connections, taps, and splices with irregularly shaped connectors (split bolts), first build them up with approved insulating putty or approved rubber insulating tape to eliminate sharp corners and voids. Then use vinyl electrical tape to cover the splice. The engineer will only accept splices that are taped with at least 3 layers, 1/2 lapped, or covered with the equivalent amount of putty. Then cover the tape with a liberal coating of an approved electrical varnish or approved sealant providing flexible protection from oil, moisture, and corrosion.

659.3.3 Luminaires

- (1) Under the Luminaires Utility bid item, furnish and install high-pressure sodium luminaires together with hardware and fittings as the plans show. Install luminaires on luminaire arms with an initial rake of plus 3 degrees, this measurement includes the rake of the arm. Install luminaires on luminaire arms level in the longitudinal direction of the highway. Except on segments where the profile is sloped greater than 3 degrees, then the engineer will determine the longitudinal level of the luminaires.
- (2) Under the Luminaires Underdeck bid item, furnish and install High Pressure Sodium underdeck luminaires together with hardware and fittings as the plans show.
- (3) Under the Luminaires Sign Lighting bid item, furnish and install mercury vapor luminaires together with hardware and fittings as the plans show.
- (4) Under the Luminaires High Mast Lighting bid item, furnish and install high-pressure sodium luminaires together with hardware and fittings as the plans show.

659.3.4 Sign, Underdeck, and Walkway Lighting

- (1) Under the Underdeck Lighting bid item, furnish and install lighting systems under highway bridges together with hardware and fittings as the plans show.
- (2) Under the Sign Lighting bid item shall consist of furnishing and installing lighting systems on highway sign bridges together with hardware and fittings as the plans show.
- (3) Under the Lighting Units Walkway bid item, furnish and install standards and post-top high-pressure sodium luminaires, together with hardware and fittings as the plans show.
- (4) Make wires continuous without splices from the fuses to the first luminaire and from luminaire to luminaire.
- (5) For underdeck lighting, use one inch (27 mm) rigid metal conduit conforming to [section 652](#). For condulets and covers conform to the requirements for loop detector conduit in [652.2.4](#); except that for short lengths of conduit between a pull point and a luminaire the contractor will use 3/4 inch (21 mm) or one inch (27 mm) liquid tight metal conduit, depending on the number of conductors.
- (6) Install junction boxes for underdeck lighting as the plans show and as specified in [section 653](#). For underdeck luminaire mounting boxes, if necessary to mount the luminaire, use boxes made of highly corrosion resistant metal and listed for outdoor use.
- (7) For sign lighting, use 3/4 inch (21 mm) rigid metal conduit conforming to [section 652](#). For condulets and covers conform to the requirements for loop detector conduit in [652.2.4](#); except that for short lengths of conduit between a pull point and a luminaire the contractor will use 3/4 inch (21 mm) or one inch (27 mm) liquid tight metal conduit depending on the number of conductors. Do not paint the rigid steel conduit conforming to [section 652](#).

659.4 Measurement

- (1) The department will measure the Luminaires Utility bid items, the Luminaires Underdeck bid items, Luminaires Sign Lighting, and Luminaires High Mast Lighting as each individual luminaire acceptably completed.
- (2) The department will measure the Underdeck Lighting bid items as a single lump sum unit for each structure acceptably completed.
- (3) The department will measure the Sign Lighting bid items as a single lump sum unit for each structure acceptably completed.
- (4) The department will measure Lighting Units Walkway as each individual unit acceptably completed. The department will measure the concrete base under a separate bid item
- (5) The department will measure Plaques Sequence Identification as each individual plaque acceptably completed

659.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
659.0100 - 0199	Luminaires Utility (material) (watts)	EACH
659.0200 - 0299	Luminaires Underdeck (watts)	EACH
659.0300	Luminaires Sign Lighting	EACH
659.0400	Luminaires High Mast Lighting	EACH
659.0500	Sign Lighting (location)	LS
659.0600	Underdeck Lighting (location)	LS
659.0700	Lighting Units Walkway	EACH
659.0802	Plaques Sequence Identification	EACH

- (2) Payment for the Luminaires bid items is full compensation for providing all materials including luminaires, ballasts, lamps, fittings, brackets, hardware and attachments; and for luminaire fusing if required. Payment for Luminaires High Mast Lighting also includes the anchor rods, templates, nuts, and washers required under the High Mast Foundation bid item as specified in [section 660](#).
- (3) Payment for the Underdeck Lighting bid items is full compensation for grounding; for junction boxes; for luminaire mounting boxes as required; for conduit, condulets, and junction box fusing; and for hardware and fittings.
- (4) Payment for the Sign Lighting bid items is full compensation for providing conduit, condulets, luminaire supports, fuses, fuse holders, junction boxes if required, hardware and fittings; and for grounding and hand-hole fusing.
- (5) Payment for Lighting Units Walkway is full compensation for providing all materials, including pedestal base standards, luminaires, lamps, fuses, fuse holders, and all hardware and fittings needed to integrate the components into units connected to lighting branch circuit. The department will pay for the concrete base under a separate bid item.
- (6) The department will pay for wiring from the lighting underground feeder systems to any luminaires under the separate contract bid item.
- (7) Payment for Plaques Sequence Identification is full compensation for providing plaques including all installation and attachment hardware.

SECTION 660 HIGH MAST LIGHTING

660.1 Description

- (1) This section describes constructing a caisson or pile foundation for a high mast light tower, and furnishing and installing a high mast lighting tower.

660.2 Materials

660.2.1 General

- (1) Furnish materials conforming to the following:

Concrete	section 501
Concrete bridges	section 502
Luminaires	section 659
Steel piling	section 511
Steel reinforcement.....	section 505
Welding materials	section 506
- (2) If not furnished as part of an assembly, use stainless steel threaded fasteners.
- (3) Use grade A, A-FA, A-S, A-T, A-IS, or A-IP concrete for high mast foundations.

660.2.2 Pole Shafts

- (1) Furnish each pole shaft the height the plans show for the specific installation.
- (2) Furnish pole shafts constructed of structural steel conforming to ASTM A 709/A709M grade 50 (345) or approved equivalent and zinc coated conforming to ASTM A 123. Furnish pole shafts with a consistent taper from bottom to top, except the lower section may be expanded to accommodate the required apparatus. Furnish poles constructed in 40 foot to 50 foot (12 m to 15 m) sections using single thickness steel plate, except the length of the top section may be shorter to provide the required pole height. Provide the engineer with 3 copies of mill test reports that show the material used in pole shafts, anchor bases, and anchor rods conforms to this specification.
- (3) Provide a reinforced access door opening in the base of the pole shaft that secures with a cover. Furnish a cover made with stainless steel hinges that bolts shut with stainless steel hex bolts and is weather tight. Fit the cover with a stainless steel padlock hasp. The engineer will reject door latch mechanisms. The contractor shall not furnish padlocks.
- (4) Secure the opening below the base plate with a stainless steel or galvanized steel rodent screen.
- (5) Design the base plate so water does not accumulate on the top surface of the base plate inside the pole.
- (6) Before zinc coating of the pole or base plate, number each anchor rod hole in sequence on the base plate or around the bottom of the pole. Locate the numbers so they are not obscured by the zinc coating or covered by installed nuts.

660.2.3 Anchor Rods, Templates, Washers, and Nuts

- (1) Attach the pole to the concrete base with at least 8 anchor rods. For each rod, furnish 2 nuts for securing the bottom anchor plate-template, a leveling nut, bottom washer, top washer and 2 top nuts. Do not use lock washers.
- (2) Furnish anchor rods conforming to AASHTO M 314-90, Grade 55 and having a Charpy V-Notch value of 15 ft-lb (20.4 Joules (20.4 Nm)) at 40 F (5 C).
- (3) Furnish anchor rods with the top 12 inches (300 mm) and bottom 6 inches (150 mm) having a Unified National Radius roll thread.
- (4) Furnish anchor rods, washers, leveling nut, and 2 top nuts zinc coated conforming to ASTM A 153, class C. As a minimum, zinc coat the top threaded portion of the rod plus one inch (25 mm).
- (5) Furnish a steel top template and a steel bottom anchor plate-template as part of each anchor assembly. Provide a top template of sufficient gauge to hold the anchor rods securely in position at the top, and resist racking or twisting during the pour. Remove the top template after the concrete has set. Use a 1/2-inch (14 mm) thick bottom anchor plate-template and secure it to each anchor rod. Templates shall not be welded to the anchor rods. Install anchor rods and templates conforming to plan details.

660.2.4 Lowering Device

- (1) Equip the poles with a mechanical lowering system that allows servicing the luminaires and associated electrical and mechanical apparatus from the ground. Furnish lowering devices from an approved series and manufacturer.
- (2) When fully raised, provide a method of securing the luminaire ring to the fixed head assembly. The contractor may show the bottom latch and top latch systems for securing the luminaire ring on the drawings submitted for the engineer's review.
- (3) Design top latch systems to provide the operator with a means of determining whether the raising operation is complete and the luminaire ring is secure, for example, a display of pole-top flags or similar indicators. The operator observing clutch slippage does not meet this requirement.
- (4) If securing the luminaire ring to the fixed head assembly, provide a means to relieve tension from the lowering cables onto the winch assembly. Provide strain relief devices that allow removing the winch assembly for servicing while the luminaire ring remains fully raised.
- (5) Ensure that the lowering device operates off one leg of the line feeding the pole, and by means of an appropriately geared, portable drive motor that plugs into the line.
- (6) Provide adjustable torque limiters in the winch system or drive motor to prevent excessive stress on the lowering cables, and to allow for proper tensioning against the fixed head assembly.
- (7) For systems where the lifting cables meet on a transition plate, provide access to the top of the plate from the hand-hole, when the ring is fully raised, to allow cable tension adjustment. Furnish 7x9 stainless steel lifting cables. Do not use antirotational cables.

660.2.5 Fixed Head Assembly

- (1) The fixed head assembly shall include no moving parts, except for the necessary pulleys, rollers, and sheaves that guide the lowering ring, lowering cables and electrical conductors during the lowering operation. For the fixed head assembly, use stainless steel. Use pulleys, rollers, sheaves, and associated bearings, bushings, and shafts made of corrosion-resistant materials. Use permanently lubricated and sealed bearings and bushings .
- (2) For systems that use a roller assembly to support the power chord at the head frame, use an assembly made of rollers mounted between highly corrosion resistant steel plates. Ensure the power chord rides on at least 6 rollers made from acetate resin mounted on stainless steel pins. Furnish a roller assembly with a minimum bending radius of 7 inches (180 mm). If using a pulley, use a minimum radius of 8 inches (200 mm).
- (3) Furnish stainless steel lifting cable sheaves with a minimum radius of 3 inches (75 mm). Use sheaves with permanently lubricated bronze bearings and a stainless steel pin. For the depth of the vee on the pulley, use at least the diameter of the cable. Provide guards to prevent the cable from lifting off the pulley.
- (4) Protect all of the head assembly with covers, screens, or shields, to prevent entrance of dirt, moisture, ice accumulation, nesting of insects or birds or other contaminants that may harm the head assembly and operation of the lowering device.

660.2.6 Luminaire Ring

- (1) If the plans show unused luminaire tenons, install a counterweight equal in weight to a luminaire, and close the unused tenon off with a threaded cap.
- (2) Furnish either a stainless steel, or a structural steel zinc coated ring. Zinc coat conforming to ASTM A 123.
- (3) Provide an active centering system to stabilize the lowering ring as it travels along the shaft. Bumper-only or roller-only systems will be considered insufficient to meet this requirement.

660.2.7 Aviation Lights

- (1) Furnish aviation lights, associated electrical circuits, and detailing only if the plan shows.

660.2.8 Lightning Rod

- (1) Furnish silver tipped lightning rod of approved design mechanically attached to the pole shaft or head assembly, and electrically connected to the pole shaft.

660.2.9 Miscellaneous Fittings

- (1) Use stainless steel miscellaneous fittings, fasteners, and hardware.

660.2.10 Drive Motor Set

- (1) Furnish one portable drive motor set for each combination of lowering device type furnished and line voltage specified. A drive motor set consists of a 120 volt AC drill motor, a transformer with a line voltage other than 120 volts AC, power cords, controls, loadbreak disconnects, parts, fittings, and incidentals required for a complete and operable set.

660.2.11 Electrical Parts

- (1) For required conductors, overcurrent devices, grounding, surge arrestors, loadbreak disconnects, and accessories, follow the details the plans show without exception or substitution.

660.3 Construction

660.3.1 Design Calculations and Shop Drawings

- (1) Design high mast lighting support structures conforming to AASHTO design and fabrication standards for structural supports for highway signs, luminaires and traffic signals. Design the completed unit to withstand all static and dynamic loads the unit will be subjected to in service. Use a design loading that provides for installation of the full complement of 6 luminaires and the operation of the lowering device.
- (2) Design the high mast light tower and foundation using a design life of 50 years with a wind importance factor of 1.00. Design to withstand a 3 second gust wind speed of 90 mph(145 km/h). Do not use the methods of appendix C of the AASHTO standards.
- (3) Design the pole and its connections, including but not limited to the welds and anchor bolts, to the AASHTO fatigue category I criteria. Use the fatigue importance factors for category I tabulated in the AASHTO standards.
- (4) Use poles that are round or polygonal in section, and designed so that the horizontal pole deflection in any direction at the design wind velocity with a gust effect factor does not exceed 5 percent of the pole height. Measure the horizontal deflection from the vertical plane passing through the centerline of the pole at its base. The pole height is the distance from the bottom of the base plate to the top of the shaft, excluding the fixed head assembly.
- (5) Submit for review, 2 sets of structural design calculations for each type of pole and anchor assembly showing that the design conforms to the specifications. Submit to the engineer for review, 6 complete sets of shop drawings and component lists, showing the pole, its alloy identification, plate thickness, weld details, weld procedures, and tolerances; the anchor assembly; the fixed head assembly; the lowering device; luminaire ring; and other required apparatus. Ensure that all design calculations and shop drawings are signed, sealed, and dated by a registered professional engineer.
- (6) If any substantial changes from previously submitted calculations and drawings are made, submit the revisions to the engineer for review.

660.3.2 High Mast Foundations

660.3.2.1 General

- (1) If any twisting, racking, or other movement of the anchor rods out of plumb, projection, or pattern, or any damage to the threads exists the engineer will reject the entire base.
- (2) Maintain the clear distance between the soil and the reinforcing steel cage using the means the plan detail shows. Do not weld the anchor rods to each other, the reinforcing steel cage, and the templates or to any other component of the foundation.
- (3) Place the concrete in one continuous pour without construction joints. Cure concrete 7 days before applying the load.

660.3.2.2 Caisson Type Foundations

- (1) Construct as specified for concrete bridges in [502.3](#).
- (2) Produce the holes for caisson type foundations by auguring. The contractor may install a suitable casing at the same time as the auguring. Make the augured hole vertical and uniform in section. Fill irregularities in the cylindrical surface of uncased holes outside the nominal diameter with concrete at no expense to the department. If the top of the hole caves in, the engineer may require the contractor to auger the hole deeper, at no expense to the department, to obtain the required depth and section.

660.3.2.3 Pile Type Foundations

- (1) Drive piles as specified in for steel piling in [section 511](#).

660.3.3 Pole Shafts

- (1) Weld or telescope pole sections together so that the splice length is equal in strength and rigidity to the remainder of the pole shaft.
- (2) If furnishing telescoping sections, overlap the sections at least 1 1/2 times the outside diameter of the larger section at the joint. If telescoping pole shaft sections together, test fit the sections at the factory to ensure pole straightness and accuracy of the mating surfaces.
- (3) In the field, measure the overlap of joints by the following procedure: On the male end, make a chalk mark at a distance from the end equal to the required overlap plus one foot (300 mm). Then make the connection so that the distance from the end of the female section to the chalk mark is one foot (300 mm).
- (4) If welding the pole shaft or its attachments, conform to the welding requirements in [506.3.19](#), with the following provisions:
 1. Use complete-penetration welds for pole sections joined by circumferential welds and inspect all welds.
 2. Inspect all circumferential welds, all full penetration welds, and a random 25 percent of partial penetration longitudinal welds.
 3. Inspect full penetration welds by either radiographic or ultrasound inspection methods.
 4. The contractor may inspect partial penetration welds by the magnetic particle method.
 5. Make all longitudinal welds to 60 percent depth penetration, except in any location within 6 inches (150 mm) of a circumferential weld or within the joint overlap area plus 6 inches (150 mm), then make these welds to 100 percent depth penetration.
 6. The contractor may repair a circumferential weld once without the engineer's permission.
 7. Ensure that other weld repairs are engineer-approved.
- (5) Upon erection, ensure the surface of the telescoped sections present a permanent barrier to moisture entering the faying surfaces.
- (6) Before and during erection, examine the pole sections for scratches and mars, and treat them by first removing all rust and then coating the damaged area with an approved cold zinc coating compound. Remove all markings placed on the pole for purposes of fabrication, shipping, or erection.
- (7) Do not perform the final plumbing of the pole on a sunny day.
- (8) After erecting and plumbing, ensure the completed pole, with all attachments, appears straight and vertical throughout its height, except if distorted by the effects of wind or sunlight or both.

660.3.4 Anchor Assembly

- (1) Install the 2 top nuts one at a time conforming to the following method: tighten snugly with a suitable wrench; then tighten by striking a slugging wrench with a maul weighing at least 12 pounds (5.5 kg), until the nut turns no further.
- (2) Upon contract completion, deliver one slugging wrench for each size of installed nut to the engineer.

660.3.5 Lowering Device, Head Assembly and Luminaire Ring

- (1) Construct conforming to plan details and manufacturer's instructions.
- (2) Before erecting the fixed head assembly, the engineer will inspect it on the ground.

660.3.6 Final Acceptance

- (1) Before acceptance each high mast lighting tower demonstrate to the engineer that all electrical and mechanical systems function properly.

660.4 Measurement

- (1) The department will measure the High Mast Foundation bid items as a single lump sum unit for each foundation acceptably completed.

- (2) The department will measure the High Mast Lighting Tower bid items as a single lump sum unit for each tower acceptably completed.

660.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
660.0100	High Mast Foundation (location)	LS
660.0200	High Mast Lighting Tower (location)	LS

- (2) Payment for the High Mast Foundation bid items is full compensation for providing steel piling if required, concrete, reinforcing steel, and electrical conduit; for installing anchor rods, templates, nuts, and washers; for excavating; for driving steel piling if required; for installing electrical conduit, electrical ground, templates, reinforcing steel and anchor rods; for placing and curing concrete; for backfilling; and for disposing of surplus material and restoring the site. The department will pay for furnishing anchor rods, templates, nuts, and washers under the Luminaires High Mast Lighting bid item as specified in [659.5](#).
- (3) Payment for the High Mast Lighting Tower bid items is full compensation for providing anchor rods, templates, nuts, and washers; for providing the pole; for providing a drive motor set, fixed head assembly, luminaire ring, and lowering mechanism with associated mechanical and electrical components, an electrical grounding system, the pole sequence and circuit identification plaques, nuts, and washers, fittings, hardware, aviation lights if required, and lightning rod; for connecting to the electrical distribution system; and for providing slugging wrenches for each size of nut;.
- (4) The department will pay separately for luminaires under the Luminaires bid items of section 659.

SECTION 661 TEMPORARY TRAFFIC SIGNALS AND TEMPORARY RAMP METERS

661.1 Description

- (1) This section describes furnishing, installing, maintaining, and removing bridge and intersection temporary traffic signals, and temporary ramp meters.

661.2 Materials

661.2.1 General

- (1) Furnish control cabinet, signal controller, and control equipment. Provide a cabinet with a Corbin #2 door lock and an access door that allows placing the controller in emergency flash. Provide keys to the access door to the engineer and law enforcement agencies as required. Supply a controller capable of executing the timing program supplied in this contract for this temporary traffic signal. The department may request changes to the timing intervals during the project as required by construction or traffic conditions. Make all changes requested by the engineer within 24 hours. If supplying control equipment with a monitor, test the monitor with an automated programmed testing system. Test monitor annually if used for more than one year. This test verifies that the monitor complies with the intersection requirements. Attach to the monitor a verification print out tape of the test, and provide a copy to the authority having jurisdiction of the intersection.
- (2) Furnish and install the temporary electrical service for temporary traffic signals according to the requirements of the applicable electrical utility. Provide an affidavit to the electrical utility in a timely manner so the electrical utility can schedule service turn on. If the control cabinet is not mounted on the electrical service pole, add a second electrical service disconnect to the outside of the control cabinet for the convenience of emergency personnel. If required, install the electrical service.

661.2.1.1 Wood Poles, Class 4

- (1) Furnish jack pine, Norway pine, or western red cedar poles conforming to ANSI 05.1.
- (2) Trim or shave poles by machine or hand to leave a smooth surfaced pole exterior.
- (3) Use marking code letters to provide the minimum information as follows: supplier's name or trademark, plant location and year of treatment, code letters denoting the pole species and preservative used, and class numeral and pole length. The engineer may refuse the pole upon inspection depending on the physical condition of the pole.
- (4) Burn above information legibly, permanently, and squarely on the face of each pole, 10 feet +/- 2 inches (3 m +/- 50 mm) from the butt of each pole. Make these letters not less than 5/8 inch (16 mm) high.
- (5) Brand, hammer-stamp, or die-stamp these same 4 items into the bottom of each pole butt. Make these letters not less than 5/8-inch (16 mm) high. Attach a metal tag with these same 4 items to the wood pole.
- (6) Provide a definition sheet explaining all code letters and numbers to the engineer.

661.2.1.2 Cable

- (1) For traffic control cable, furnish 600 volt AC 14 AWG, solid copper conductor, according to IMSA 20-1.
- (2) Wire sizes called for under the various Cable bid items are minimum requirements; the department will determine if larger wire size is needed to keep the voltage drop below 5 percent.

661.2.1.3 Guy, Span, and Messenger Wire

- (1) Furnish 3/8-inch (10 mm) nominal diameter, 7-strand, zinc-coated steel wire conforming to ASTM A 475, with a utility grade breaking strength of 15,400 pounds (7000 kg).

661.2.1.4 Guy, Span, and Messenger Wire Mounting Hardware

- (1) Furnish engineer-approved hardware consisting of the following: machine bolts, 1 1/2-inch (38 mm) curved square washers, straight to angle thimbleye bolts, thimble eyenuts, angle thimbleye eyes, ovaleye bolts, standard eye nuts, twisted loop dead-end grips, 3 bolt guy clamps, bolted deadends, serving sleeves, messenger hangers, drive hooks, sidewalk guy fittings, guy wire thimbles, guy strain insulators, guy safety markers, anchor rods, guy adapters, expanding anchors, and screw anchors.
- (2) Furnish 5/8-inch (16 mm) minimum diameter bolts with square nuts. For eye hardware, use dropforged steel. Use galvanized metal hardware.

- (3) For straight-line bolted deadends, furnish malleable iron with steel hardware and a minimum breaking strength of 11,500 pounds (5200 kg). Fasten to the span pole using an ovaleye bolt.
- (4) For twisted loop dead-end grips, furnish the same material as specified in [661.2.1.3](#). Use grips with a nominal diameter of 3/8 inch (10 mm) that accommodate 7-strand wire and have a minimum breaking strength of 11,500 pounds (5200 kg).
- (5) Furnish 3 bolt guy clamps having a minimum breaking strength of 11,500 pounds (5200 kg).
- (6) For guy strain insulators, furnish ANSI class 54-2 insulators with maximum wire diameter of 1/2 inch (13 mm) and minimum tensile strength of 12,000 pounds (5450 kg).
- (7) Separate sidewalk guy fittings by no more than 6 feet (2 m) of 2-inch (50 mm) rigid metallic galvanized conduit. Attach the pole plate to the pole with one 5/8-inch (16 mm) machine bolt and two 1/2-inch (13 mm) by 4-inch (100 mm) minimum lag bolts.
- (8) For guy safety markers, use yellow or orange plastic a minimum of 7 feet (2 m) long.
- (9) For anchor rods, furnish 5/8-inch (16 mm) minimum diameter rods with a minimum breaking strength of 11,500 pounds (5200 kg).
- (10) Use expanding anchors having a minimum expanded area of 125 square inches (80 645 mm²).
- (11) Use screw anchors having a minimum helix area of 78 square inches (50 322 mm²) 10-inch (254 mm) diameter with a minimum rod diameter of 1 1/4 inches (31.75 mm) and 66 inches (2 m) long.

661.2.1.5 Tether and Messenger Wire

- (1) Furnish 1/4-inch (6.35 mm) nominal diameter, 7-strand, zinc coated steel tether wire conforming to ASTM A 475 with common grade breaking strength of 1900 pounds (882 kg).

661.2.1.6 Temporary Traffic Signal Control Cabinet Base

- (1) Furnish a 3/4-inch by 4-foot by 6-foot (19 mm x 1.2 m x 2 m) sheet of exterior grade plywood for the base. Provide wooden stringers 4-inch (100 mm) square by a specified length as needed. Seal bases to prevent rodents from entering the cabinets.

661.2.1.7 Testing

- (1) Deliver all cabinet assemblies for temporary signal operation to the department's electrical shop for testing. The shop is located at:

3625 Pierstorff Street
Madison, Wisconsin, 53704

- (2) Deliver the complete cabinet, including the controller, cabinet accessories, complete wiring diagrams, and related documentation, ready for installation in the field. Provide and deliver with the cabinet all required appurtenances to test the full functionality of the cabinet assemblies. If the department requires, demonstrate to, and instruct the department personnel in the use of all testing appurtenances. Contact the department's representative 48 hours before delivery to confirm delivery dates and times. The department will examine and test the cabinet assembly for up to 3 days, after which the contractor shall pick up the assembly. If the department finds that the assemblies are defective or unsuitable, or if the quality does not conform to acceptable standards, remove the unacceptable cabinet, correct all deficiencies, and deliver revised assemblies to the department as specified above. Do not install any assembly until it receives department approval.
- (3) If not providing new traffic signal faces, obtain the engineer's approval before delivering them. The engineer will base approval on inspection of the lens clarity, assessing dirt and scratches, and body integrity, assessing holes, cracks, and rain tightness.

661.2.2 Temporary Traffic Signals for Intersections

661.2.2.1 Tether Wire Mounting Hardware

- (1) Furnish galvanized wire rope tether wire clips, drive hooks, serving sleeves.

661.2.2.2 Signal Faces

- (1) Furnish the housing, visor, optical units, lenses, reflectors, and lamp receptacle conforming to ITE standards for adjustable face vehicle traffic control signal heads.
- (2) Furnish traffic signal lamps conforming to ITE standards for traffic signal lamps.

661.2.2.3 Span Wire and Tether Wire Signal Head Mounting Hardware

- (1) Furnish only fittings designed for span wire mounting applications. The contractor may also use these fittings for the tether wire connection, or the contractor may use a tether clamp assembly. Use hardware of unpainted aluminum or that is federal yellow in color. For traffic signal head mounting lock nuts, use 1 1/2-inch (38 mm) hexagon, galvanized malleable iron. Use nuts 1/2 inch (13 mm) thick and measuring 2 1/2 inches (64 mm) across flat to flat.
- (2) Use reinforcement plates, stiffener plates, or both, as the signal head manufacturer recommends.

661.2.3 Temporary Traffic Signals for Bridges

- (1) Furnish 4 x 6 wood posts conforming to [section 634](#).
- (2) Furnish LED modules as specified in [658.3.2](#).
- (3) Furnish mounting hardware referenced in [661.2.1.4](#), properly sized for wire diameter being used.
- (4) Furnish traffic signal mounting hardware as specified in [658.2.1](#).
- (5) If mounting the control cabinet to a wood pole or post, mount it with two 3/8-inch by 3-inch (10 x 75 mm) lag bolts.

661.2.4 Temporary Ramp Meters

661.2.4.1 Cable

- (1) For signal current carrying neutral condition, furnish 10 AWG, rated USE, RHH, RHW, copper single conductor, 600 volt AC, cross-linked polyethylene insulated. Ensure that the 10 AWG USE current carrying neutral wire is white in color.

661.2.4.2 Span Wire and Tether Wire Signal Head Mounting Hardware

- (1) Furnish fittings designed for span wire mounting applications. The contractor may also use these fittings for the tether wire connection, or the contractor may use a tether clamp assembly. Use hardware of unpainted aluminum or that is federal yellow in color. For traffic signal head mounting lock nuts, use 1 1/2-inch (38 mm) hexagon, galvanized malleable iron, class 150 pipe fitting. Use nuts 1/2 inch (13 mm) thick and measuring 2 1/2 inches (64 mm) across flat to flat.
- (2) Use reinforcement plates, stiffener plates, or both, as the signal head manufacturer recommends.

661.2.4.3 Splice Box

- (1) Furnish PVC or metal with a minimum size of 8-inch by 6-inch by 4-inch (200 x 150 x 100 mm). Use a waterproof box with a hinged cover.

661.2.4.4 Signal Faces

- (1) Furnish the housing, visor, optical units, lenses, reflectors, and lamp receptacle conforming to ITE standards for adjustable face vehicle traffic control signal heads.
- (2) Furnish traffic signal lamps conforming to ITE standards for traffic signal lamps.

661.2.4.5 LED Modules

- (1) Furnish LED modules as specified in [658.3.2](#).

661.3 Construction

661.3.1 General

- (1) Perform work according to the WSEC. Provide and install wood poles, posts, tether wire, messenger wire, tether wire hardware, messenger wire hardware, guy wire, span wire, guy wire hardware, and span wire hardware, traffic signal cable, traffic signal faces mounting hardware, electrical service, traffic signal faces, traffic signal faces with backplates, including providing, installing, and programming the controller with control cabinet as the plans shows.
- (2) Request a signal inspection of the complete temporary traffic signal installation. Make this request to the engineer at least 3 working days before the requested inspection. DOT district electrical personnel will perform the inspection.
- (3) The engineer will not grant turn on approval until the contractor corrects all discrepancies.

661.3.1.1 Wood Poles, Class 4

- (1) The engineer will determine final pole positions after marking the utilities.
- (2) Place the pole in the ground to no less than 1/5 of the pole's length as the plans show.
- (3) Remove all loose materials from the hole before setting the pole. Tamp all bank run gravel backfill every foot of fill. Before attaching span wires or messenger wires, rake all poles one foot at the top of the pole and guy if needed.
- (4) Review the plans before pole installation to ensure adequate pole height.

661.3.1.2 Wire and Cable

- (1) Ensure traffic signal cables and lighting cable contain the number of conductors indicated on the traffic signal wiring diagrams.
- (2) Attach all cables to the span wire or messenger wire, at 3-foot (1 m) or less intervals with 4 wraps of an department-approved adhesive tape or UV resistant, outdoor rated nylon lock fasteners.
- (3) Install all cable in continuous lengths without splices in any cable run. Only splice cable on the pole. If any opening in the insulation occurs other than the end of the wire or cable, replace the wire or cable.
- (4) Make splices using a twist locked, wire nut, type connection. Point the spliced conductors upward and cover with plastic. Place the splice a minimum of 11 feet (3.3 m) above finished grade level.
- (5) Feed all traffic signal cables to signal faces as the detail drawings show.
- (6) If anticipating freezing weather during the term of this contract, use weatherproof splice boxes.

661.3.1.3 Temporary Traffic Signal Control Cabinet Base

- (1) Attach the plywood to the stringers with nails or lag bolts. If using lag bolts, countersink the washer and the bolt head flush with the plywood surface. Arrange stringers to be underneath all 4 sides of the cabinet.
- (2) Secure the cabinet base using an anchor mounted on each corner and make flush with the top of the temporary cabinet platform.
- (3) For anchors, use 4-inch by 4-inch (100 x 100 mm) wood post, or a galvanized 1 5/8-inch by 1 5/8-inch (40 x 40 mm) channel with a minimum length of 3 feet (1 m). Secure the anchors to the cabinet base with lag bolts.

661.3.1.4 Maintenance

- (1) Maintain all minimum and maximum heights to the signal faces as the plans show. Verify the span heights throughout the project duration.
- (2) Place all signal faces as the plans show. Make every effort to give maximum visibility to all signals intended for view by the motoring public.
- (3) Provide the name, address, and telephone number of the persons qualified and assigned to maintaining the temporary traffic signal to the engineer, local police, and county sheriff, also, post this information on the temporary traffic signal control cabinet, and cover with weatherproof material. Ensure this persons is available 24 hours a day, 7 days a week, from the start of the project until the temporary traffic signal is not needed. Ensure that emergency calls are received by an individual and not by an answering machine.

661.3.2 Temporary Traffic Signals for Intersections and Temporary Ramp Meter

661.3.2.1 Tether Wire Mounting Hardware

- (1) Form loops on the end of the tether wire, hook over drive hooks and hold in place using wire rope tether clips. Secure loose tether wire ends using serving sleeves.

661.3.2.2 Tether Wire

- (1) Keep all tether wire free of splices or kinks.
- (2) Install the tether wire at 17 feet (5.2 m) to 19 feet (5.8 m) over the roadway.
- (3) Install the tether wire in direct vertical alignment with the guy wire.
- (4) If no signal heads are attached between the span wire and tether wire, attach a tension control cable. Use the tension control cable to maintain minimum height. Use a tension control cable consisting of tether wire and wire rope tether wire clips. Use 1/4-inch (6 mm) galvanized U-bolts on both ends, top and bottom, of the tension control cable to prevent movement.

661.3.2.3 Wire and Cable

- (1) Ground all metallic parts including span, tether, and guy wire with hardware, light arms and luminaires, splice boxes and pole guards. Ground each electrically isolated assembly at one end by mechanically attaching (lug or split bolt) the equipment-grounding conductor (6 AWG stranded copper wire) that terminates at a 5/8-inch by 8-foot (16 mm x 2.6 m) grounding electrode installed at the wood pole base. For the equipment-grounding conductor use an exothermic weld or clamp to the grounding electrode. Ensure all grounding hardware is UL listed.

661.3.2.4 Span Wire

- (1) Install the span wires free of any splices or kinks. Install the span wire mounted signal faces so the bottom is a maximum of 19 feet (5.8 m) above the roadway (minimum height is 17 feet (5.2 m)). Compute the vertical height of the span wire on the span pole using the following formula:

$$HD (0.05) + RC + HH = SH$$

- (2) HD equals the horizontal distance between the span poles.
- (3) RC equals the roadway clearance. If lowering the proposed roadway under the span wire, use minimum clearance over the roadway value.
- (4) HH equals the head length (height) including all span wire mounting hardware.
- (5) SH equals the span wire height above the roadway.
- (6) To use the value SH from the formula, mark from the elevation of the roadway on the span pole and measure up the pole the distance SH from this mark. This is where the top span wire should dead end on the span pole.
- (7) Review the plans before pole installation to ensure adequate pole height due to grade changes.

661.3.2.5 Span Wire and Tether Wire Signal Head Mounting Hardware

- (1) Support each signal head by a span wire-mounting bracket and attach to the tether wire.
- (2) Feed all span wire signals through the top span wire-mounting bracket. Provide sufficient cable slack to enable moving the signal head along the span as the engineer directs. Neatly coil and attach the extra signal cable to the upper span wire until it is needed.
- (3) Mount the heads vertically and plumb.

661.3.2.6 Implementation and Removal

- (1) Before activating the temporary traffic signal or temporary ramp meter, verify the signal indications and operation of the signal to the engineer.
- (2) Upon acceptance of new signal and completion of work, the department will switch control of the intersection over to the permanent cabinet installation. Remove all signal cable and wires, wood poles, wood posts, control cabinet, control equipment, and incidental materials. Upon deactivation of the controller, call the electrical utility immediately for the temporary electrical service disconnect.
- (3) Remove the temporary traffic signal faces the same day the permanent traffic signal is turned on.
- (4) Immediately remove the wood poles and wood posts obstructing the view of the new permanent signal faces. Remove remaining wood poles and wood posts within 3 working days of new permanent signal activation.
- (5) Immediately after removing the wood poles and wood posts, backfill the holes, compacting every 12 inches (300 mm) with engineer-approved material.

661.3.2.7 Maintenance

- (1) Correct lamp outages within 24 hours of the reported outage.
- (2) Respond within one hour of notification to provide corrective action to any emergency such as but not limited to knockdowns, signal cable problems, and all controller equipment failures. If equipment becomes damaged or faulty beyond repair, replace it within one working day. In order to fulfill this requirement, maintain, in stock, sufficient amounts of materials and equipment to provide repairs. Replace the traffic signal control equipment including the cabinet, controller, and cabinet accessories within 4 hours.

- (3) All far through indications suspended on the span wire shall be located above the center of the controlled lane. The far right signal shall be mounted over the center of the right through lane. The far left turn signals shall be suspended straight ahead of the left turn lane.

661.3.3 Temporary Traffic Signals for Bridges

- (1) If attaching the cable to the structure is the only possible method of spanning the project, then protect the cable and attach to the bridge according to additional special provisions and construction detail drawings (both supplied by the designer).
- (2) If using trailer mounted traffic signals, conform to NEMA standard TS1.
- (3) Provide one 120 volt, 60-cycle generator with a minimum rating of 1500 watts, as the energy source to operate the traffic signal on this project. Provide diesel, gasoline, or propane-powered generators. Provide one auxiliary generator on the site as backup.
- (4) Maintain and operate the generators on a 24-hour a day, 7 days a week basis. This includes having a responsible contact person respond to the project site, within 1/2 hour of receiving a call, for any emergency to the electrical supply system.
- (5) If the temporary traffic signal is not operable, provide flaggers until normal operation resumes.
- (6) Furnish the electrical cable and the required electrical connections, conforming to the NEC, to connect the generators to the temporary traffic bridge signal. The engineer will determine the location of the generators in the field.

661.3.3.1 Messenger Wire

- (1) Use 1/4-inch (6 mm) wire as specified in [661.2.1.5](#) or 3/8-inch (10 mm) wire as specified in [661.2.1.3](#).

661.3.3.2 Messenger Wire Hardware

- (1) Use dead-end hardware sized for the messenger wire used as the plans show.

661.3.3.3 Wood Posts

- (1) The engineer will determine final postpositions after marking the utilities.
- (2) Place 4 x 6 wood posts in the ground to no less than 1/5 of the post length or as the engineer directs.
- (3) Remove all loose materials from the hole before setting the post. Tamp all bank run gravel backfill every foot (300 mm) of fill.
- (4) Review the plans before post installation to ensure adequate post height.

661.3.3.4 Implementation and Removal

- (1) Before activating the bridge temporary traffic signal, verify the signal indications and operation of the signal to the engineer.
- (2) Upon completing the repair work on the bridge, and if the engineer determines that the bridge temporary traffic signal is no longer needed, remove the signal cable, messenger wire, wood poles, wood posts, control cabinet, control equipment, and incidental materials. Upon deactivation of the controller, call the electrical utility immediately for the temporary electrical service disconnect.
- (3) Immediately after removing the wood poles and wood posts, backfill the holes with engineer-approved material. Compact the material in 12-inch (300 mm) lifts.

661.3.3.5 Maintenance

- (1) Immediately correct all LED outages.
- (2) Respond within one hour of notification to provide corrective action to any emergency such as but not limited to knockdowns, signal cable problems, and all controller equipment failures. If equipment becomes damaged or faulty beyond repair, replace it. In order to fulfill this requirement, maintain, in stock, sufficient amounts of materials and equipment to provide repairs. Replace the traffic signal control equipment including cabinet, controller, and cabinet accessories within 2 hours.

661.3.4 Temporary Ramp Meter

- (1) Notify the engineer 10 days before starting any temporary ramp meter work. The engineer will notify the district freeway operations personnel who will verify ramp timings and validate communications.

- (2) Load the timing parameters into the controller the department provides.
- (3) Minimum mounting height of the box is 11 feet (3.4 m). Ground splice box if made of metal.

661.4 Measurement

- (1) The department will measure the Temporary Traffic Signals for Bridges, Temporary Traffic Signals for Intersections, and Temporary Ramp Meter bid items as a single lump sum unit for each structure or intersection acceptably completed.
- (2) The department will measure Generators by the day acceptably completed, based on a 24 hours per day operation.

661.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
661.0100	Temporary Traffic Signals for Bridges (structure)	LS
661.0200	Temporary Traffic Signals for Intersections (location)	LS
661.0300	Generators	DAY
661.0700	Temporary Ramp Meter (location)	LS

- (2) Payment for the Temporary Traffic Signals for Bridges, Temporary Traffic Signals for Intersections, and Temporary Ramp Meter bid items is full compensation for providing, operating, maintaining, and repairing the complete temporary installation; and for removal. Payment also includes the following:
 - 1. Furnishing and installing the replacement equipment.
 - 2. All utility installation fees and energy costs through completion of the project.
 - 3. The cost of delivery and pick-up of the cabinet assemblies.
- (3) Payment for Generators is full compensation for providing, maintaining, and operating generators, including fuel and oil; for providing and locating a backup generator at the site; and for providing flaggers if required.

SECTION 670 GENERAL REQUIREMENTS FOR INTELLIGENT TRANSPORTATION SYSTEMS

670.1 Description

- (1) This section describes additional personnel qualifications, construction methods, and testing requirements used to perform ITS work.

670.2 Materials

- (1) Furnish ITS materials conforming to the general requirements for electrical work as specified in [651.2](#).

670.3 Construction

670.3.1 General

- (1) Perform all ITS work conforming to the general requirements for electrical work as specified in [651.3](#).

670.3.2 Personnel Qualifications

670.3.2.1 Field System Integrator

- (1) Perform ITS work with onsite assistance and under the supervision of a qualified field system integrator selected from the department's approved field system integrator list. The field system integrator shall provide assistance and expertise to the contractor in the areas of equipment installation, operation, integration with existing equipment, testing, and network management. The field system integrator is responsible for ensuring all equipment installed operates as the plans show. Assistance is required in the submission of material lists, shop drawings, documentation, as-builts, test results, training and operation manuals and presentations, wiring schematics, equipment test procedures.
- (2) The department defines ITS work as related construction required under the contract, performed according to these specifications, the special provisions, and plans applicable to electrical construction.
- (3) Proof of qualification to do field system integrator work shall meet a minimum of 2 years experience in at least 3 of the following:
 - Maintain or service traffic signal controllers, including NEMA, 170, and 2070 controllers.
 - Install, maintain, integration, or service of vehicle detection systems including, but not limited to, inductive loop sensors, video detection, microwave detectors, and acoustic sensors.
 - Install, maintain, integration, or service of digital communications equipment on either fiber optic or microwave networks. The experience must include a minimum of work with SONET networks, multiplexes, and video encoders and decoders.
 - Install, maintain, integration, or service of computer networks and network equipment including switches, routers, hubs. Provide documentation of training and work experience in network management, SNMP, and software integration.
 - Install, maintain, integration, or service dynamic or variable message displays of various types including LED and flip disk.
 - Install, maintain, integration, or service of closed circuit television systems for traffic surveillance or security. Knowledge of control systems, video signals, switches, and encoding devices is required.
 - Install, maintain, integration, or service of fiber optic cable including splicing and termination. Provide documentation of work history and training that includes a minimum of one 4-day class on fiber optic equipment installation conducted by a major manufacturer of fiber optic equipment, or a FOA certification as a fiber optic technician.

670.3.2.2 Certified Fiber Optic Technician

- (1) Have a certified fiber optic technician perform all work for fiber optic terminations, splicing, and testing. Have a certified fiber optic technician supervise all fiber optic cable installation.
- (2) Submit material to certify technicians meet the following requirements:
 - Education: attend and successfully complete at least one 4-day class on installation of fiber optic products conducted by major manufacturer and have FOA certification.
 - Work history: demonstrate a minimum of 2 years work experience in the last 5 years with splicing, termination, and testing of fiber optic cable.
- (3) Remove, replace, and reinstall work performed by non-certified technicians for fiber optic communications equipment and material.

670.3.3 Testing

670.3.3.1 Contractor-Furnished Equipment and Materials

- (1) Furnish all equipment necessary to test the completed installation. Test and demonstrate to the engineer's satisfaction that all equipment is in working order.
- (2) Submit documentation required that demonstrates component performance and operation as specified in contract.
- (3) The field system integrator will approve final set up and testing of all equipment and materials.
- (4) Perform all tests on weekdays during normal working hours. Obtain the engineer's approval for test times and dates.
- (5) Resubmittal of rejected equipment or material is allowed for consideration with proof of correction and testing. The department may approve rejected material but is not considered final acceptance for equipment or material until final post-installation testing.

670.3.3.2 Department-Furnished Equipment and Materials

- (1) The department will test department-furnished equipment and material before the contractor takes possession of it. Coordinate with the department to assist and witness testing. If the contractor fails to coordinate with the department, once in possession of equipment and material, the contractor shall take full responsibility for replacement of damaged or malfunctioning components or other elements.
- (2) The department will replace damaged, malfunctioning components, or other elements associated with equipment or material if found during testing.

670.3.3.3 Post-Installation Testing

- (1) Furnish test procedures for each component in the contract. A component is defined as a subsystem confined to the end functionality of the device. Components include field devices, processor, assemblies, cabling, connections, communications, and any additional elements associated with proper operation and full functionality of the field device.
- (2) Submit 5 copies of component test procedures to the department. The field system integrator and contractor shall develop test procedures 30 days before initial installation. The department will approve test procedure within 30 days of the date received and provide a written approval.
- (3) Resubmit rejected test procedures within 15 days of notification. The department will provide written approval of resubmitted test procedures within 30 days of the date received.

670.3.4 ITS Documentation

670.3.4.1 Pre-Construction Work

- (1) Provide 5 copies of equipment list and drawings 28 days after notice of award to the engineer. The engineer will review the equipment list and drawings within 30 days of submittal. Obtain the engineer's written approval before procuring equipment and beginning the work.
- (2) Equipment list will include all bid items in the work and contain names and addresses of all manufacturers, catalog tear sheets showing catalog numbers, and specifications. Resubmit a new alternative for all partial or totally rejected equipment within 15 days of written notice. The engineer will review within 30 days of submittal.
- (3) Do not make substitutions or changes to engineer-approved materials without the engineer's written approval. Check the availability, price, and delivery date before making submittal of equipment or material.

670.3.4.2 Post-Construction Work

- (1) The department will not consider the project complete and accepted as final under [105.11.2.4](#) until after the contractor provides 5 copies of the ITS documentation. The ITS documentation includes but is not limited to the following:
 - Operator's manual: submit a manual containing detailed operating instructions for each different type or model of equipment and or operation performed.
 - Maintenance procedures manuals: submit a manual containing detailed preventive and corrective maintenance procedures for each type or model of equipment furnished in the work.

- Cabinet fiber optic wiring diagram: submit a cabinet wiring diagram, identified by location for each cabinet. Include both electrical wiring and fiber optic conductor and cable connections. Place one copy of the fiber optic wiring diagram in a weatherproof holder in the cabinet. Deliver the other copies to the department or engineer.
- As-built drawings: submit final as-built drawings that detail the final placement of all conduit, cabling, equipment, and geometric modifications within the contract. Provide all documentation in an electronic format adhering to the district's ITS computer aided drafting standards and according to the department's as-built requirements. The department will review the as-built drawings for content and electronic format. Modify both the content and format of as-built drawings until meeting all requirements.
- Equipment inventory list: submit an inventory list including serial number, make, model, date installed, and location installed of all equipment installed under the contract.

670.4 Measurement

- (1) The department will measure Field System Integrator and ITS Documentation as a single lump sum unit for each service acceptably completed.

670.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
670.0100	Field System Integrator	LS
670.0200	ITS Documentation	LS

- (2) Payment for Field System Integrator and ITS Documentation is full compensation for providing specified expertise, assistance, and documents. The department will pay separately for other ITS work under the various ITS bid items of section 671 through section 679.
- (3) The department will not make additional payment for removing, replacing, and reinstalling work performed by non-certified technicians as required under [670.3.2.2](#).

SECTION 671 INTELLIGENT TRANSPORTATION SYSTEMS - CONDUIT

671.1 Description

- (1) This section describes furnishing and installing conduit for ITS work and furnishing and installing permanent flexible above ground markers along a path of any fiber optic cabling and existing manholes installed.

671.2 Materials

671.2.1 Conduit

- (1) Furnish high-density polyethylene (HDPE) smooth, solid-wall conduit rated for outdoor and underground use. Ensure that the HDPE is burn resistant and conforms to Belcore GR-356-CORE and conditional requirement CR5-14. Use the size the plans show with a size-to-diameter ratio (SDR) of 11 and conforming to the following:

NOMINAL INSIDE DIAMETER	NOMINAL OUTSIDE DIAMETER
1.25 inches (31.75 mm)	1.660 inches (42.164 mm)
2 inches (50.8 mm)	2.375 inches (60.325 mm)
3 inches (76.2 mm)	3.50 inches (88.9 mm)

- (2) The construction and testing of the conduit shall comply with all applicable EIA/TIA, ANSI, and ASTM standards.
- (3) Furnish each 4-duct package individually distinct in color: blue, orange, brown, and green.
- (4) Furnish bends, adapters, couplings, fittings, and other materials used to install conduits. Meet all of the duct manufacturer's installation recommendations. Furnish anodized aluminum reverse threaded couplers sized as appropriate.

671.2.2 Woven Pull Tape

- (1) Furnish and install woven pull tape for all ducts in the run. The woven pull tape shall have documentation as duct cutting resistant, tensile strength of greater than 1100 pounds (500 kg), nominal width of 1/2 inch (13 mm), and maximum allowable elongation under pulling tension of 10 percent.

671.2.3 Fiber Optic Cable Marker

- (1) Furnish fiber optic cable markers made of composite reinforced thermoplastic, white and orange in color, a minimum of 62 inches (1575 mm) long, 3 inches (75 mm) wide, and stamped with CAUTION FIBER OPTIC CABLE on the front and back of the marker.

671.3 Construction

671.3.1 Installing Conduit

- (1) Install conduit by plowing or trenching.
- (2) Do not exceed the minimum bending radius of the cable installed in the conduit. Do not pull cable over edges or corners, over or around obstructions, or through unnecessary curves or bends.
- (3) Use directional bore installations if the contract specifies.
- (4) Repairs are not permitted. Remove broken, chipped, cracked, or impaired lengths of fittings or conduit and replace with new materials. Do not install conduit above ground or on structures.
- (5) Provide information to the engineer as specified in [107.22](#). Expose the main to provide visual inspection by the utility owner for gas mains of 100 psi (690 kPa) or greater, or 12 inches (300 mm) in diameter or greater.

671.3.2 Woven Pull Tape

- (1) Provide woven pull tape at each raceway point in acceptable to the engineer. If cables are blown directly through the ducts, woven pull tape for those sections of individual ducts is not required. All spare conduits shall have woven pull tape installed in the duct.

671.3.3 Fiber Optic Cable Marker

- (1) Provide installation at locations the plans show. Installation should be adequate so that marker cannot be pulled out or removed manually. The marker should self erect after vehicle impact.

- (2) Install markers so that all lengths of installed fiber optic cables in new conduit have a minimum of one marker. Install a minimum of 2 markers along each fiber optic cable path in new conduit so that one forward and one behind are always visible. Install a marker at each point along the fiber optic cable path where a 45-degree or greater change in direction occurs. Install a marker at each existing manhole at locations where the fiber optic cabling is installed into existing conduit networks. Install markers a maximum of 24 inches (600 mm) lateral displacement from the actual placement of the conduit and fiber optic cabling. Install markers no later than 3 days following the installation of conduit to contain fiber optic cables, or of direct buried fiber optic cables. Safeguard the conduit and cables during the installation of the markers. Remove and replace any conduit or cables as the plans show that are damaged during marker installation at no additional cost to contract.

671.4 Measurement

- (1) The department will measure the Conduit HDPE and Conduit HDPE Directional Bore bid items by the linear foot acceptably completed, measured along the centerline of the conduit from centerline of fitting to centerline of fitting or end of conduit, or between ends of conduit, or between ducts
- (2) The department will measure Fiber Optic Cable Marker as each individual marker acceptably completed.

671.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
671.0100 - 0199	Conduit HDPE (duct) (size)	LF
671.0200 - 0299	Conduit HDPE Directional Bore (duct) (size)	LF
671.0300	Fiber Optic Cable Marker	EACH

- (2) Payment for the Conduit HDPE and Conduit HDPE Directional Bore bid items is full compensation for providing, hauling, and installing all materials including conduit, fittings, couplers, and bends; for pull wires or ropes; for expansion fittings and caps; for excavating, bedding, backfilling, and restoration of ground to original condition including sand, concrete, or other required materials; for disposing of surplus materials; and for making inspections.
- (3) Payment for Fiber Optic Cable Marker is full compensation for providing and installing all materials including restoration of ground to original condition including topsoil, sand, concrete, or other required materials; and for disposing of surplus materials.

SECTION 672 INTELLIGENT TRANSPORTATION SYSTEMS - BASES

672.1 Description

- (1) This section describes constructing concrete bases for ITS concrete controller cabinets and camera poles.

672.2 Materials

672.2.1 General

- (1) Use schedule 40 PVC electrical conduit conforming to the electrical conduit specified in [section 652](#).
- (2) Furnish bar steel reinforcement conforming to [505.2](#).
- (3) Furnish grade A, A-FA, A-S, A-T, A-IS, or A-IP concrete conforming to [501.2](#).

672.2.2 Base ITS Controller Cabinet

- (1) Furnish stainless steel bolts, studs, nuts, washers, and either mechanical wedge or epoxy type stainless steel masonry anchors. Thread at least 12 inches (300 mm) of the anchor rod. Ensure that anchors conform to the following:
 - Minimum yield strength of 92,000 psi (635 MPa).
 - Minimum elongation of 14 percent in 4 inches (100 mm).
 - Minimum pull-out strength of 9000 pounds (40 kN)

672.2.3 Base Camera Pole

- (1) Furnish anchor rods, nuts, and washers conforming to AASHTO M 314 grade 55. Ensure that rods have a Charpy V-Notch test value of 15 foot-pounds (20.4 Nm) or greater at 40 F (5C). Use roll threaded anchor rods. Ensure that the entire length of the anchor rods, the nuts, and the washers are hot-dip zinc coated according to AASHTO M 232. Use zinc coated nuts manufactured with sufficient allowance to allow nuts to run freely on the threads.
- (2) Furnish grounding electrodes that are one solid rod with a minimum 8-foot (2.4 m) length and 5/8-inch (16 mm) diameter made of the copper clad type or engineer-approved equal. Furnish a separate 6 AWG stranded bare copper wire to run to pole base.

672.3 Construction

672.3.1 General

- (1) Construct concrete bases including necessary hardware at locations the engineer determines.
- (2) Construct concrete base for ITS controller cabinet and camera pole according to [section 501](#), and provide the surface finish specified in [502.3.7.2](#) and as the plans show. Inspect the forming and applicable reinforcement for concrete bases before pouring the concrete. Cure the bases for 7 days before installing any material on them.
- (3) Review plans for the number, size, and direction of conduit entrances required at location before placing concrete.

672.3.2 Base Camera Pole

- (1) Drive a grounding electrode vertically into the ground outside the concrete base. Exothermically weld copper wire to the grounding electrode, run to, and terminate at a grounding lug inside the pole base.
- (2) Furnish design drawings for approval before constructing camera pole base to the engineer. Design drawings must be certified by a registered professional engineer.

672.4 Measurement

- (1) The department will measure Base ITS Controller Cabinet and the Base Camera Pole bid items as each individual base acceptably completed.

672.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
672.0100	Base ITS Controller Cabinet	EACH
672.0200 - 0299	Base Camera Pole (length)	EACH

- (2) Payment for Base ITS Controller Cabinet is full compensation for providing and installing all materials including conduit, bushing, caps or plugs, or both, anchor rods, nuts, washers, bar steel reinforcement if required, and concrete; for excavating, bedding, backfilling, and restoration of ground to original condition including sand, concrete, or other required materials; and for disposing of surplus materials.
- (3) Payment for the Base Camera Pole bid items is full compensation for providing and installing all materials including conduit, bushing, caps or plugs, or both, anchor rods, nuts, washers, grounding electrodes, exothermic welds, copper equipment-grounding wires, bar steel reinforcement if required, and concrete; for excavating, bedding, backfilling, and restoration of ground to original condition including sand, concrete, or other required materials; and for disposing of surplus materials.

SECTION 673 COMMUNICATION VAULT

673.1 Description

- (1) This section describes constructing a communication vault and vault lid.

673.2 Materials

- (1) Furnish a communication vault and vault lid constructed of a polymer concrete material and gray in color.
- (2) Furnish a communication vault shall be one piece measuring 30 inches by 48 inches (750 x 1220 mm) and a minimum of 57 inches (1450 mm) high. Stackable vaults are not permitted.
- (3) Furnish a vault lid with a minimum design load of 15,000 pounds (66.7 kN) and that has permanent stamp that reads WISDOT COMMUNICATIONS or as the plans show. The vault lid will have 2 slots measuring 1/2 inch by 4 inches (13 x 100 mm) to use as a pull out.
- (4) Furnish manufactured gaskets, from the department's approved products list, between the lid and top of vault to resist water from entering the communications vault.
- (5) Furnish fiber optic cable support assembly consisting of multiple brackets, racks, and rails required to suspend the required surplus cabling and any splice enclosures for a single communication vault. Furnish support assemblies from the department's approved products list made from or coated with a weather resistant material to ensure no corrosion.
- (6) Furnish self-curing caulking to provide a permanent bond and made of flexible rubber that is not affected by sunlight, water, oils, mild acids, and alkali. Use mildew-resistant and non-flammable, gray caulk .

673.3 Construction

- (1) Construct communications vault according to [section 611](#).
- (2) Provide a manufacturer-approved knockout punch driver to provide openings in the communication vault for conduit if not provided. Voids between conduit and vault shall not exceed 1/2 inch (13 mm). Caulk the interior and exterior of communication vault. Cure caulking according to manufacturer's specifications before backfilling.
- (3) Secure vault lid to vault with two 3/8-inch (9.5 mm) 16 UNC stainless steel pentahead bolts and washers to lock the lid.
- (4) Anchor the support assemblies to the existing vault using stainless steel hardware.

673.4 Measurement

- (1) The department will measure the Communication Vault bid items as each individual vault acceptably completed.

673.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
673.0100 - 0199	Communication Vault (type)	EACH

- (2) Payment for the Communication Vault bid items is full compensation for providing and installing all materials including vaults, lids, gasketing, bolts, washers, stainless steel mounting hardware, fiber optic cable support assembly, caulking; for excavating, bedding, backfilling, and restoration of ground to original condition including sand, aggregate, concrete, or other required materials; and for disposing of surplus materials.

SECTION 674 INTELLIGENT TRANSPORTATION SYSTEMS - CABLE

674.1 Description

- (1) This section describes furnishing, removing, reinstalling, and installing ITS electrical wire and cable.

674.2 Materials

674.2.1 ITS Communication Cable

- (1) Furnish communication cable conforming to IMSA 20-6. Use 6 pairs of 18 AWG in each cable. Twist conductors 12 turns per foot (39 turns/m) by the individual pair.
- (2) Furnish ITS communication cable and terminations conforming to Rural Electrification Administration (REA) specification PE-22. Use 6-pair, 12-pair, or 25-pair communications cable 19 AWG solid copper with color-coded polyethylene insulation, black polyethylene outer jacket, and aluminum tape shield between jackets required to connect ramp meter and detector processor assemblies.

674.2.2 Microwave Detector Cable

- (1) Furnish 12 twisted pairs, 20 AWG, solid copper or color-coded polyethylene insulation, black polyethylene outer jacket, aluminum tape shield between jackets, and gel filled. The pair-utilization shall be as follows:

Pair 1: power.	Pair 7: detection zone contact closure.
Pairs 2 and 3: RS-232 bus for laptop computer.	Pair 8: detection zone contact closure.
Pair 4: detection zone contact closure.	Pair 9: detection zone contact closure.
Pair 5: detection zone contact closure.	Pairs 10 through 12: spare.
Pair 6: detection zone contact closure.	

674.2.3 Reinstall Cable

- (1) Reinstall existing group of cables removed within a section of conduit as the plans show.

674.3 Construction

674.3.1 ITS Communication Cable

- (1) Under the Cable ITS Communication bid items, install 6 pair, 12 pair, and 25 pair copper communication cable as the plans show.
- (2) Install, terminate, and test twisted pair copper communications cable in the processor cabinets in order to transmit and share data communications between cabinets.
- (3) Prevent copper communication cable from damage during installation and storage. Do not step on or run over by any vehicle or equipment. Do not pull along the ground, or over or around obstructions.
- (4) Seal copper communication cable ends at all times during installation using a heat shrinkable end cap from the department's approved products list. Do not use tape. Keep sealed until termination. For cable not immediately terminated, provide a 4-foot (1200 mm) length of cable extending out of the cabinet opening.
- (5) Use cable grip to pull cable through conduit designed to provide a firm hold on exterior covering of cable.
- (6) Do not pull copper communication cable through any intermediate junction box, pull box, or any other opening in conduit or duct, unless the engineer approves. Pull the necessary length to be installed from the pull box or cabinet to the immediate next downstream pull box or cabinet. Carefully store remaining length of copper communication cable to prevent damage and in a manner not hazardous to pedestrian or vehicular traffic. Cable shall enter a pull box or cabinet directly from the cable reel or storage directly out of the immediate downstream pull box or cabinet.
- (7) Install copper communication cable with out splices between hub or processor assembly cabinets.
- (8) Do not exceed the minimum bending radius at anytime during installation. Do not pull over edges or corners, over or around obstructions, or through unnecessary curves or bends. Copper communication cable shall be looped in and out of cabinets and pull boxes to provide adequate slack and the least amount of stress on conductors.
- (9) Use manufacturer's recommended pulling tension for pulling copper communication cable by the outer jacket or 80 percent of the manufacturer's maximum pulling tension whichever is smaller.

- (10) Use engineer-approved lubricant at manufacturer's recommended amount to facilitate pulling cable. Lubricate as it is fed off of the cable reel or storage stack into the cable feeder. Place lubricator funnel around the cable just ahead of the feeder. After installation, clean the copper communication cable with a cloth at a pull box or cabinet before leaving.
- (11) Provide slack in cable as shown on plan or one full turn in box for pull boxes and a minimum of 6 feet for cabinets.
- (12) Terminate cable pairs entering a cabinet on termination blocks located in ramp meter and detector processor assembly cabinets in a neat and orderly fashion and according to the REA color code. Ground cable shield for each run at only one of the termination locations. Attach 8 AWG grounding wire to the shield with an engineer-approved clamp according to REA PC-2.
- (13) Test the copper communication cable following installation:
 - Use a megger to perform ground resistance testing of all conductors including the shield, and conductor-to-conductor, including all individual conductors to the shield. Ensure that all conductor tests, including the shield, read infinity to ground, and from conductor to conductor and all individual conductors to the shield, read infinity. Replace cable not meeting the infinity test result at no expense to the department, whether one or many readings per cable are defective.
 - Test continuity of each pair to show a resistance of not more than 8 ohms per 1000 feet (300 m) of conductor. Use meter with a minimum input resistance measurement of 20,000 ohms per volt.

674.3.2 Microwave Detector Cable

- (1) Furnish, install, terminate, and test all cables and connectors required to connect the microwave detector assembly with the processor assembly as the plans show.
- (2) Prevent cable from damage during installation and storage. Do not step on or run over by any vehicle or equipment. Do not pull along the ground, or over or around obstructions.
- (3) Seal cable ends at all times during installation using a heat shrinkable end cap from the department's approved products list. Do not use tape. Keep sealed until connectors are installed.
- (4) Install cable with out splices between microwave detectors and processor.
- (5) Provide slack in cable as plan shows a minimum of 6 feet (1.8 meters) for cabinets.
- (6) Test the cable following installation as follows:
 - Use a megger to perform ground resistance testing of all conductors including the shield, and conductor-to-conductor, including all individual conductors to the shield. Ensure that all conductor tests, including the shield, read infinity to ground, and from conductor to conductor and all individual conductors to the shield, read infinity. Replace cable not meeting the infinity test result at no expense to the department, whether one or many readings per cable are defective.
 - Test continuity of each pair to show a resistance of not more than 8 ohms per 1000 feet (300 m) of conductor. Use meter with a minimum input resistance measurement of 20,000 ohms per volt.

674.3.3 Removing Cable

- (1) Remove the existing group of cables within a section of existing conduit as the plans show.
- (2) Use caution not to damage any remaining cables from existing conduits as the plans show. Remove all existing cable connections from the cabinet or remove splices.
- (3) Test cable continuity, and identify and mark all cables before removal to ensure proper reconnection.
- (4) Demonstrate and document existing damage to engineer. Non-compliance to demonstrate and document existing damage shall make repair the responsibility of the contractor.

674.3.4 Reinstalling Cable

- (1) Reinstall existing group of cables removed within a section of conduit as the plans show.
- (2) Provide a liberal coating of an engineer-approved electrical varnish or sealant to allow flexible protection from oil, moisture, and corrosion.
- (3) Provide a pressure or compression fitting for electrical splices and connections from the department's approved products list.
- (4) Replace damaged cables in kind at no additional expense to the department.
- (5) Remake all cable connections.

674.4 Measurement

- (1) The department will measure the Cable ITS Communication bid items by the linear foot acceptably completed, measured along the centerline of the conduit, including slack between terminations within the ramp meter processor assemblies.
- (2) The department will measure Cable Microwave Detector by the linear foot acceptably completed, measured along the centerline of the conduit, including slack to its connection with the proper terminals in the processor assembly cabinet.
- (3) The department will measure Remove Cable by the linear foot acceptably completed, measured along the centerline of the conduits removed between 2 points such as pull boxes, manholes, or other points defined.
- (4) The department will measure Reinstall Cable by the linear foot acceptably completed, measured along the centerline of the conduit run in which the group of cables was reinstalled.

674.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
674.0100 - 0199	Cable ITS Communication (pairs)	LF
674.0200	Cable Microwave Detector	LF
674.0300	Remove Cable	LF
674.0400	Reinstall Cable	LF

- (2) Payment for the Cable ITS Communication bid items is full compensation for providing cables; for excavating trenches, backfilling, restoring disturbed or damaged areas, including seeding and sodding; for making connections and testing installed cable system; and for disposing of surplus material.
- (3) Payment for Cable Microwave Detector is full compensation for providing cable and connectors; for making necessary connections; and for all testing.
- (4) Payment for Remove Cable is full compensation for removing existing cables; for undoing all connections and terminations, including wire nuts, splice kits, tape, insulating varnish or sealant, and ground lug fasteners; and for all testing.
- (5) Payment for Reinstall Cable is full compensation for reinstalling existing cables; for remaking all connections, including wire nuts, splice kits, tape, insulating varnish or sealant, and ground lug fasteners; and for all testing.

SECTION 675 CONTROLLERS AND DETECTORS

675.1 Description

- (1) This section describes installing controllers, ramp meter, detector processor assemblies, and department-furnished microwave detectors.

675.2 (Vacant)

675.3 Construction

- (1) Perform a series resistance test and resistance to ground test at each loop/lead-in circuit before starting any work as specified in [section 670](#).
- (2) For all new loop/lead-in circuits, perform a series resistance test and resistance to ground test. Ensure that the series resistance of each circuit is less than 5 ohms. Ensure that the insulation resistance of loop conductors to ground, and between adjacent loops/lead-in circuit is infinite as measured with a 500 volt megger test meter.
- (3) If any work proceeds at a location without completion of the loop detector testing, assume responsibility for the ultimate correct operation of the loop/lead-in.
- (4) Secure fasten ramp meter processor assembly cabinets on new, modified, or existing concrete bases at locations the plans show. Provide bolted stainless steel connections with lock washers, locking nuts, or other engineer-approved means to prevent the connection nuts from backing off. Isolate dissimilar materials from one another by stainless steel fittings.
- (5) Make all power connections to the processor assembly cabinet as specified in [section 656](#).
- (6) Make all detector cable and communications cable connections to the processor assembly cabinet to provide the required operation. The engineer will provide the contractor with wiring diagrams showing the required field wire terminations within the processor assembly cabinet for each detection zone.
- (7) Make all traffic signal cable connections and electrical wire connections to the processor assembly cabinet as specified in [section 676](#).
- (8) Terminate signal current carrying neutral conductors on a neutral strip mounted in the cabinet. Isolate the neutral bus from the cabinet and equipment ground. Terminate the neutral bus at the neutral lug ultimately attached in the meter pedestal.
- (9) Ground all cable grounding shields and any spare or unused conductors in the ramp meter processor assembly cabinet to the equipment-grounding terminal strip.
- (10) Isolate the equipment-grounding strip from the cabinet and current carrying neutral. Terminate the cabinet current carrying neutral at the current carrying neutral ground lug in the meter pedestal or breaker disconnect box.
- (11) Reuse existing wiring to the existing, modified, or new concrete control cabinet base unless the engineer directs otherwise. Wiring includes bonding wire, conductors and loop detector lead-in cable, and loop detector wire.
- (12) Make all connections between the processor assembly and the multipoint device interface units and telephone interface modems at locations the plans show.
- (13) The department will provide processor assembly firmware. The department will install the processor firmware on contractor-supplied EPROM's. Pick up the EPROM's with firmware from the department, and install it into each controller before installation.
- (14) Upon completing all installation work at a location, before detector verification and conducting the testing procedure, perform the new loop/lead-in circuit series resistance test and resistance to ground test. Ensure that the series resistance of each circuit is less than 5 ohms. Ensure that the insulation resistance of loop conductors to ground, and between adjacent loop/lead-in circuit, is infinite as measured with a 500 volt megger test meter. Document the test results, and submit them to the engineer as part of the set up to begin the testing procedure.
- (15) Demonstrate the functionality and accuracy of the vehicle detectors connected to each location. Verify that the traffic flow information obtained from each detector is within +/- 5 percent of each of two 10-minute manual data periods.

- (16) After installing the processor assembly; installing all other ramp control signal assembly hardware, detection hardware, communications hardware, power supply, and connecting cabling; and successfully completing, documenting and presenting, to the engineer, all testing and verification, the field system integrator, following the contractor-submitted and engineer-approved testing procedure, shall successfully conducted a field test for each processor assembly. The test is designed to demonstrate that all hardware, cable, and connections furnished and installed by the contractor operates correctly and that all functions are in conformance with the specifications. It is not necessary to test all locations concurrently.
- (17) Do not begin ramp meter processor assembly test until the following have been accomplished:
- Testing of new and existing loop detectors.
 - Testing of ramp control signal wiring.
 - Submission of documented results to the engineer.
 - Installation of all ramp signing and pavement marking, including HOV and trailblazing.
- (18) The contractor may conduct the test within 48 hours after the field system integrator advises the engineer that it is ready to begin the test, the processor is communicating to central, and all documentation has been presented. Begin the test once the field system integrator has satisfied itself that all work has been completed at each processor assembly location. After the processor assembly has been placed in operation, the field system integrator shall demonstrate that all equipment furnished and installed by the contractor operates as specified herein.
- (19) After successful completion of the test procedure, test each processor assembly for proper operation for 30 consecutive days. During the testing period, ensure that all contractor-provided equipment at the assembly location operates without failures of any type. If any component malfunctions or fails to provide the specified capabilities, during the 30-day test period, the field system integrator shall replace or repair the defective equipment within 48 hours of notification by the engineer.
- (20) After the component malfunction has been corrected to the satisfaction of the engineer, begin a new 30-day test period. The 30-day test applies only to contractor-furnished hardware. In the event of a failure of hardware furnished by others that prevents the 30-day test from continuing, the engineer will suspend the 30-day test until the other hardware failures are corrected, at which time the test will resume.

675.4 Measurement

- (1) The department will measure Install Controller Ramp Meter Processor Assembly, Install Controller Detector Processor Assembly, and Install Mounted Controller Microwave Detector Assembly as each individual assembly acceptably completed.

675.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
675.0100	Install Controller Ramp Meter Processor Assembly	EACH
675.0200	Install Controller Detector Processor Assembly	EACH
675.0300	Install Mounted Controller Microwave Detector Assembly	EACH

- (2) Payment for Install Controller Ramp Meter Processor Assembly and Install Controller Detector Processor Assembly is full compensation for installing the processor assembly, for making all connections, and for all testing.
- (3) Payment for Install Mounted Controller Microwave Detector Assembly is full compensation for installing the mounting brackets on poles, for installing the microwave detector on the bracket, for making all connections, for positioning the detector to provide the optimum field of view, for setting up and programming the detector, and for all testing.
- (4) The department will not pay for correcting the loop/lead-in or for correcting component malfunctions exposed during the 30-day testing period. The department will not make complete payment under a bid item in this section until each processor assembly completes a successful test over 30 consecutive days without interruption by any contractor-furnished component malfunction.

SECTION 676 SIGNAL ASSEMBLIES

676.1 Description

- (1) This section describes furnishing and installing traffic signal assemblies.

676.2 Materials

676.2.1 General

- (1) Since overhead ramp control, display enforcement, and type 2 advance flasher signal assemblies are mounted on existing poles, the requirements specified in [676.2.2](#) and [676.2.3](#) are not applicable.

676.2.2 Traffic Signal Standards

- (1) Furnish traffic signal standards conforming to [657.2.4](#). Use standards with an overall length of 13 feet (4 m), except for type 1 advance flasher signal assemblies, use 15-foot (4.6 m) standards.

676.2.3 Pedestal Bases

- (1) Furnish pedestal bases conforming to [657.2.5](#). Use square bases with a 12 3/4-inch (325 mm) bolt circle.

676.2.4 Signal Heads

- (1) Furnish the housing, visor, optical units, lenses, reflectors, and lamp receptacle the conforming to ITE standards for adjustable face vehicle traffic control signal heads.
- (2) Furnish traffic signal lamps conforming to ITE standards for traffic signal lamps.
- (3) For each lens receptacle, provide with 2 color-coded 18 AWG or larger rubber covered lead wires conforming to ASTM specifications, securely fastened to the socket, and of sufficient length to reach the terminal block.
- (4) Furnish signal indications having round lenses with a 12-inch (300 mm) or 8-inch (200 mm) nominal diameter, as the plans show.
- (5) Illuminate each lens independently of any other lens with 165 watt, 1950-lumen 8000-hour, 125 volt traffic signal lamps in all 12-inch (300 mm) lenses; 67 watt, 8000-hour, 125 volt traffic signal lamps in all 8-inch (200 mm) lenses.
- (6) Use lamp sockets for 67 watt lamps designed to place the 2 7/16-inch (62 mm) focal length lamp filament at the 3-inch (75 mm) distance as required in 8-inch (200 mm) green and yellow signal head reflectors.
- (7) Use lamp sockets for 165 watt lamps designed to place the 3-inch (75 mm) focal length filament at the 3-inch (75 mm) distance as required in 12-inch (300 mm) red signal head reflectors.
- (8) Furnish traffic signal faces from the department's approved products list.

676.2.5 Signal Mounting Brackets

- (1) For all exterior mountings and assemblies of the signal faces, use unpainted aluminum or plastic.
- (2) Adequately protect all trunions, brackets, and suspensions used for assembling and mounting traffic signal heads against atmospheric conditions, and ensure that they are entirely weather tight. All threaded signal head support hardware shall be IPS 1 1/2-inch (38 mm) pipe size. Coat all threaded assemblies of metallic parts with a rust, corrosion, and anti-seize protection compound.
- (3) Mount all vertical-mounted signal heads on 4 1/2-inch (115 mm) outside diameter signal standards on the side of the post. Use standard mounting brackets and clamps from the department's approved products list.
- (4) Install pinnacles in all holes of upper and lower signal head mounting brackets.
- (5) Where 2 brackets with 2 mounting holes in each bracket are used, secure the bracket to a wood pole or post using two 3/8-inch by 3-inch (10 x 75 mm) lag screws.
- (6) Mount brackets banded to poles or standards so the traffic signal assemblies are immovable. Use 3/4 inch (19 mm) wide, 0.025 inch (0.635 mm) thick, stainless steel banding. Use stainless steel clips.
- (7) To complete the raceway from a pole or standard mounting bracket to the signal head, use galvanized 1 1/2-inch (38 mm) elbows and tees, or engineer-approved equal. Use 1 1/2-inch (38 mm) galvanized rigid metal conduit nipples.

- (8) Furnish hardware for closing 1 1/2-inch (38 mm) openings in heads or bracket ends from the department's approved products list.
- (9) Furnish pinnacle type hardware for closing signal heads or bracket ends from the department's approved products list. Use 1 1/2-inch (38 mm) neoprene washers to seal the top of a head or the top of the top head in an array of heads, to the upper mounting bracket to keep moisture out of the heads.
- (10) Use 1 1/2-inch (38 mm) traffic signal head mounting nuts from the department's approved products list.
- (11) Use 1 1/2-inch (38 mm) by 1 3/4-inch or 2-inch (45 or 50 mm) length close nipples, as required. Use nipples with tapered pipe thread on one end and running thread on the other end.
- (12) Use spacers, when required, made of corrosion resistant material.
- (13) Use one-inch metallic conduit conforming to [section 652](#).

676.2.6 Sidemount Sign Mounting Brackets

- (1) For all exterior sign mountings, use unpainted aluminum or plastic.
- (2) Adequately protect all trunions, brackets, and suspensions used for mounting traffic signs against atmospheric conditions, and ensure that they are entirely weather tight. All threaded support hardware shall be IPS 1 1/2-inch (38 mm) pipe size. Coat all threaded assemblies of metallic parts with a rust, corrosion, and anti-seize protection compound from the department's approved products list.
- (3) Mount brackets banded to poles or standards so the sign assemblies are immovable. Use 3/4 inch (19 mm) wide, 0.025 inch (0.635 mm) thick, stainless steel banding. Use stainless steel clips.

676.3 Construction

676.3.1 General

- (1) Perform work conforming to sections 651, 655, 657, and 658, the WEC, and as the plans show.
- (2) Perform work under this section using a journeyman electrician as specified in [651.3.2](#).
- (3) Do not erect pole shafts for the signal structures until the concrete footings have cured for at least 7 days.
- (4) Drill and tap all cast signal bases for an equipment-grounding bolt. Use a 10-32, 1/2-inch (13 mm) long brass bolt used in conjunction with a UL-approved grounding lug. Place the bolt in the left side of the base approximately 4 inches (100 mm) from the front corner of the door side and approximately 6 inches (150 mm) up from the bottom of the base. Coat the bolt with an anti-seize compound from the department's approved products list.
- (5) Ensure that the positioning, mounting height, and lateral placement of signal heads are according to the MUTCD. For overhead signals, provide a clearance from the pavement surface of the roadway to the lowest part of the mast arm, or the lowest part of any object mounted on the mast arm, between 17 feet (5.2 m) and 19 feet (5.8 m) . The contractor may be required to revisit locations to re-adjust the signal heads once the engineer observes the metering operation of the ramp.
- (6) Seal voids between the pole or mast arm and mounting bracket by using silicon or rubberized caulking, or similar engineer-approved materials.
- (7) If using 2 brackets with 2 mounting holes in each mounting bracket, use only the upper bracket, upper hole to bolt the bracket to a pole or pedestal. The mounting bolt shall be a stainless steel, hex head cap screw, 3/8-inch (10 mm), with 24 threads per one inch (25 mm). Drill or tap the pole or pedestal to match. Do not allow the cap screw to extend more than 1/4 inch (6 mm) through the wall, into the interior cavity of the pole or pedestal. Use a stainless steel flat washer sized to properly cover the bolt hole in the bracket and a stainless steel lock washer with each cap screw. Band the lower end of the upper bracket and the lower bracket to the pole or pedestal.
- (8) Ensure that the white current carrying neutral conductor and the green grounding conductor conform to the requirements of 10 AWG.
- (9) Verify the number of conductors required in the cable runs, and submit the cable arrangements to the engineer for approval. Also provide the number of excess conductors the plans show for future use. The engineer will verify conductor totals. Wrap conductors from multi-conductor cables that are spares or unused in the bases at this time back along the multi-conductor cable, and tape them to the cable. Leave a 2-foot (600 mm) length of cable or wire in each hand hole for termination. Leave an extra 6 feet (1.8 m) of each cable in each pull box.

- (10) For traffic signal cable that extends from the signal base to the terminal strips in the signal heads, provide the number of conductors as the plans show. Match the color of the conductor to the lens color.
- (11) Where using vinyl electrical tape, provide an insulation capacity equal to that of the remainder of the conductors. Use a vinyl tape from the department's approved products list.
- (12) Cover tape with a liberal coating of an electrical varnish from the department's approved products list.
- (13) Make electric splices and connections with pressure or compression fittings from the department's approved products list.
- (14) Verify that the maximum ampere load in the hot line to the signal indications does not exceed 10.5 amperes. For the maximum current flow in the current carrying neutral from the signal indications, do not exceed 21 amperes.
- (15) Install conductors in continuous lengths without splices from terminal to terminal. Splice only at hand holes at the bases of the standards or poles. Do not splice in underground pull boxes or conduit.
- (16) Group and identify sets of conductors in signal cables, 3 each per signal phase, whether insulated with red, yellow, green, or other colors, at each pertinent termination. Use conductors colored to match lens colors first. The engineer shall approve the method of identification. Furnish 2 as-built cable layout drawings with labeling to the engineer upon completion of the work. Place one of those copies in the cabinet.
- (17) Ensure that the 14 AWG white current carrying neutral extending from the signal base to the terminal strip in the signal heads is 12 inches (300 mm) longer (on the base side) than the colored 14 AWG conductors.
- (18) Connect the white 14 AWG wires to a 10 AWG current carrying neutral. Make the connection with a wire-nut. Extend the 10 AWG wire from the current carrying neutral grounding strip in the ramp meter processor assembly cabinet, being installed from base to base to the far end of each signal conduit run.
- (19) Furnish the 10 AWG USE XLP current carrying grounded conductor in white colored insulation.
- (20) Furnish the 10 AWG USE XLP equipment-grounding wire in green colored insulation.
- (21) Make the equipment-grounding connection in the signal pedestal base or pole transformer base by way of a pigtail and wire nut to a 10 AWG copper grounding conductor. Extend the 10 AWG wire from the equipment-grounding strip in the ramp meter processor assembly cabinet, being installed from base to base to the far end of each signal conduit run. Strip bare the length of 10 AWG equipment ground conductor exposed from the raceway in each base.
- (22) For the pigtail, use a 12-inch (300 mm) bare copper wire; equip one end with a spade or eyelet, and place it under the head of a bolt tapped into the base. Attach poles with a grounding electrode at their base and attached to the pole-grounding terminal to this equipment-grounding wire.
- (23) Furnish all equipment and appliances necessary to test the complete installation of the ramp meter control signal assembly, including all electrical conductors.
- (24) Test and demonstrate to the engineer's satisfaction that the circuits are properly connected, continuous, and free from short circuits and unspecified grounds; that they are connected according to the manufacturer's wiring layout; and that each circuit is operational. The work is not complete until all electrical work is completed and all electrical systems are in proper working order.

676.3.2 Installation

- (1) Use traffic signal cable between signal assemblies and the processor assemblies conforming to [section 655](#).
- (2) Furnish all equipment and appliances necessary to test the complete installation of the signal assemblies, including all electrical conductors.
- (3) Provide type II reflective signs, as specified in [section 637](#).

676.4 Measurement

- (1) The department will measure the Signal Assembly bid items as each individual assembly acceptably completed.

676.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
676.0100	Signal Assembly Ramp Control Sidemount	EACH
676.0105	Signal Assembly Ramp Control Overhead	EACH
676.0200	Signal Assembly Display Enforcement	EACH
676.0300 - 0399	Signal Assembly Advance Flasher (type)	EACH

- (2) Payment for the Signal Assembly bid items is full compensation for providing traffic signal standards, pedestal bases, signal heads, signal mounting brackets, and sign mounting brackets; for providing all electrical connections and grounding; and for all testing.
- (3) The department will pay separately for cable under the appropriate Cable Traffic Signal and Electrical Wire Traffic Signals bid items as specified in [655.5](#).
- (4) The department will pay separately for signs and mounting those signs under the Signs Reflective Type II bid item as specified in [637.5](#).
- (5) Department will not pay for the first 2 trips required to revisit and readjust signal heads as required under [676.3.1](#). The department will pay for subsequent trips, if required, as extra work.

SECTION 677 CAMERAS

677.1 Description

- (1) This section describes installing camera assemblies and associated poles, base plates, and camera lowering systems.

677.2 Materials

- (1) The department will provide camera assemblies.
- (2) Under the Install Camera Assembly bid item, furnish cables and connectors required to transmit video and camera control data between the camera assembly and the camera controller assembly. Conform to the following:
 1. For the camera control cables between the control receiver and pan/tilt unit, and between the control receiver and the camera/lens, use SDN flexible shielded control cable. Use cable that has a neoprene outer jacket and is rated at 600 volt. The cables shall consist of stranded 22 AWG conductors minimum. Use a sufficient number of conductors to provide the control features and power requirements specified. Use MS connectors or other department-approved connectors at the control receiver. Use polymer/nylon conductor insulation.
 2. Use video cable between the camera unit and the control receiver made with RG-59U coaxial cable, dual-foil shield and 100 percent braid. Use BNC or MS connectors.
 3. Combine camera control and video into the same composite cable, if possible.
 4. Integrate the camera assembly with the camera lowering system.

677.3 Construction

- (1) Under the Install Camera Pole bid item, install camera poles on new concrete bases at locations the plans show and conforming to [section 657](#).
- (2) Coat all threaded assemblies of metallic parts with a rust, corrosion, and anti-seize protection compound from the department's approved products list.
- (3) Furnish and install all incidental items, such as wire nuts, grommets, tape connectors, electrical nuts, etc., obviously necessary to make the proposed closed circuit television (CCTV) system complete from the source of supply to the most remote unit.
- (4) Install anchor bases on the concrete base using leveling shims from the department's approved products list. Adjust shims to plumb the pole under load.
- (5) Assemble the camera, zoom lens, camera enclosure, and pan/tilt unit before delivery to the job site. Deliver the assemblies to the job site as complete units, and install units on top of the camera poles using a pole mounting adapter as the plans show.
- (6) Mount camera enclosures directly to the mounting plates of the pan/tilt drives.
- (7) Mount pan and tilt drives to the poles as the plans show. Electrically bond the pole-mounting adapter to the pole. Electrically bond the pan/tilt drive to the mounting adapter.
- (8) Mount the camera assembly so that when the pan and tilt unit is at the mid-point of its mechanical motion, the orientation of the camera's line of sight is as the plans show.
- (9) Furnish and install camera cables in conduit and poles as the plans show. Provide continuous cable runs without splices between the camera assembly and the camera controller assembly.
- (10) Take every precaution to ensure that the cable is not damaged during storage or installation. Workmen should not step on cable or run over by any vehicle or equipment. Do not pull the cable along the ground or over or around obstructions.
- (11) Keep cable ends sealed at all times during installation using a cable end cap from the department's approved products list. Do not use tape to seal the cable end. Keep the cable end sealed until connectors are installed.
- (12) Do not exceed the minimum-bending radius of the cable at any time.
- (13) Provide a 6-foot (1.8 m) cable slack for cabinets.
- (14) The contractor or field system integrator shall furnish all equipment, appliances, and labor necessary to test the installed camera cable between the camera assembly and the camera controller assembly. Successfully perform the following tests before any connections are made.

- (15) Perform continuity tests on the coax element of the camera cable using a metallic time domain reflectometer (MTDR) with chart recorder. Camera cable shall not exhibit any discontinuities such as opens, shorts, crimps, or defects.
- (16) Perform continuity tests on the stranded conductors element of the camera cable using a meter having a minimum input resistance of 20,000 ohms per volt. Each conductor shall show a resistance of not more than 16 ohms per 1000 feet (300 m) of conductor.
- (17) Measure the insulation resistance between conductors, and between each conductor, ground, and shielding using a megger. Ensure that the resistance is infinite.
- (18) Should any cable fail to meet the test parameters, or should any testing reveal defects in the cable, replace the cable at no expense to the department. Retest the new cable as specified above.
- (19) The ATMS field system integrator shall submit copies of the test results, including any unsuccessful and subsequently successful tests to the engineer before any field operations testing.
- (20) Either shelf mount the control receivers or mount them directly into the 19-inch rack in the cabinet.
- (21) Make all camera cable connections between the camera controller assembly cabinet, control receiver, surge protector, and video transmitter, as required to provide a fully operational CCTV system.
- (22) After the camera controller assembly has been installed, and all other camera hardware, power supply, and connecting cabling has been installed, the ATMS field system integrator shall successfully perform a field test for the camera location. Conduct the test at the camera controller assembly cabinet, and include the following:
 - 1. Verification of installation of specified cables and connections between camera, pan and tilt unit, and control receiver.
 - 2. Local operation of all CCTV equipment exercising the pan, tilt, zoom, focus, iris opening, and manual iris control selection and operation, washer/wiper, and power on/off functions -- while observing the video picture on a portable video and waveform monitor.
 - 3. Demonstration of camera sensitivity at low light levels to meet the specified requirements.
 - 4. Demonstration of pan/tilt speed and extent of movement to meet the specified requirements.
 - 5. Measurement of video signal level at the network interface (input to video transmitter) with a waveform monitor to verify NTSC Standards.
- (23) Furnish all test equipment.
- (24) After all field CCTV equipment and telephone interface devices have been installed and successfully tested and the new cameras have been integrated into the existing central camera controller, the ATMS field system integrator shall test the intertie with the central camera control hardware and all new CCTV system components installed under this contract. The tests shall include the following:
 - 1. Verification that all interconnecting cable installations (video transmitter, camera's and camera controller) conform to the specifications.
 - 2. Operation of all camera assemblies from the central camera controller exercising the pan, tilt, zoom, focus, iris opening, and washer and wiper functions while observing the video picture on the local monitor and on monitors at central.
 - 3. Verification of camera and lens preset programming.
- (25) Following successful completion of the above tests, activate the entire CCTV subsystem and leave it on for 30 consecutive days. During this period, ensure that all materials and components of the CCTV subsystem furnished and installed operate as specified and without any failure.
- (26) In the event that any contractor-provided component of the CCTV subsystem malfunctions or operates below the level specified, the department will terminate the test period, and will require the ATMS field system integrator to determine and correct the problems, including repair or replacement of equipment, at no cost to the department. Upon correction of the problems, the engineer will start a new 30-day test period. If a malfunction is the result of equipment not installed by the contractor, the engineer will suspend the acceptance test period until the responsible party corrects these problems.

677.4 Measurement

- (1) The department will measure Install Camera Pole and Install Camera Assembly as each individual unit acceptably completed.

677.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
677.0100	Install Camera Pole	EACH
677.0200	Install Camera Assembly	EACH

- (2) Payment for Install Camera Pole is full compensation for installing all materials, including poles, mounting adapter, camera lowering system, all hardware, and fittings necessary to completely install the pole; and for installing identification plaques when required.
- (3) Payment for Install Camera Assembly is full compensation for installing the camera assembly on the camera pole; for providing camera cables; and for installing the camera controller assembly, control receiver, and all connections.

SECTION 678 COMMUNICATION SYSTEMS

678.1 Description

- (1) This section describes the furnishing, installing, and testing of communication systems.

678.2 Materials

678.2.1 Fiber Optic Splices

- (1) Furnish fiber optic splice enclosures to be used in fiber optic splices for both mainline end-to-end splices and drop splices, as the plans show.
- (2) Furnish fiber optic splice enclosures designed for use under the most severe conditions such as moisture, vibration, impact, cable stress and flex temperature extremes as demonstrated by successfully passing the factory test procedures.

678.2.1.1 Physical Requirements

- (1) The enclosure must handle up to 4 cables in a butt configuration. The contractor may use a butt adapter to increase capacity to 6 cables.
- (2) The enclosure must prevent the intrusion of water without the use of encapsulates.
- (3) The enclosure must be capable of accommodating splice organizer trays that accept mechanical, fusion, or multi-fiber array splices. The splice enclosure shall have provisions for storing fiber splices in an orderly manner, mountings for splice organizer assemblies, and space for excess or unspliced fiber. Splice organizers shall be re-enterable. Splice cases shall hold a sufficient number of splice trays to hold up to 144 splices.
- (4) The splice case shall be UL rated.
- (5) Enclosure re-entry and subsequent reassemble shall not require specialized tools or equipment. Further, these operations shall not require the use of additional parts.
- (6) The splice enclosure shall have provisions for controlling the fiber bend radius to a minimum of 1 1/2 inches (38 mm).

678.2.1.2 Factory Testing

678.2.1.2.1 General

- (1) Ensure that the manufacturer or an independent testing laboratory performs the tests listed below in [678.2.1.2.2](#) through [678.2.1.2.6](#). Submit certificates of compliance to the department. Manufacturer certification is necessary for the model of enclosure supplied. It is not necessary to test each supplied enclosure.

678.2.1.2.2 Compression Test

- (1) The enclosure shall not deform more than 10 percent in its largest cross-sectional dimension when subjected to a uniformly distributed load of 300 pound-force (1335 N) at a temperature of -1 F (-18 C) and 100 F (38 C). Perform the test after stabilizing at the required temperature for a minimum of 2 hours. It shall consist of placing an assembled enclosure between 2 flat paralleled surfaces, with the longest enclosure dimension parallel to the surfaces. Place the weight on the upper surface for a minimum of 15 minutes. Take the measurement with weight in place.

678.2.1.2.3 Impact Test

- (1) The assembled enclosure shall be capable of withstanding an impact of 20.65 foot-pounds (28 Nm) at temperatures of -1 F (-18) and 100 F (38 C). Perform the test after stabilizing the enclosure at the required temperature for a minimum of 2 hours. The test fixture shall consist of 20-pound (9 kg) cylindrical steel impacting head with a 2-inch (50 mm) spherical radius at the point where it contacts the enclosure. Drop the enclosure from a height of 12 inches (300 mm). The enclosure shall not exhibit any cracks or fractures to the housing that would preclude it from passing the water immersion test. There shall be no permanent deformation to the original diameter or characteristic vertical dimension by more than 5 percent.

678.2.1.2.4 Cable Gripping and Sealing Test

- (1) The cable gripping and sealing hardware shall not cause an increase in fiber attenuation in excess of 0.05 dB/fiber at 1550 nm when attached to the cables and the enclosure assembly. The test shall consist of measurements from 6 fibers, one from each buffer tube or channel, or randomly selected in the case of a single fiber bundle. Take the measurements from the test fibers, before and after assembly to determine the effects of the cable gripping and sealing hardware on the optical transmission of the fibers.

678.2.1.2.5 Vibration Test

- (1) The splice organizers shall securely hold the fiber splices and store the excess fiber. Test the fiber splice organizers and splice-retaining hardware according to EIA standard FOP-II, test condition I. The individual fibers shall not show an increase in attenuation in excess of 0.1 dB/fiber.

678.2.1.2.6 Water Immersion Test

- (1) The enclosure shall be capable of preventing a 10-foot (3 m) water head from intruding into the splice compartment for a period of 7 days. Test splice enclosure by the placing of the enclosure into a pressure vessel and filling the vessel with tap water to cover the enclosure. Apply continuous pressure to the vessel to maintain a hydrostatic head equivalent to 10 feet (3 m) on the enclosure and cable. Continue this process for 30 days. Remove the enclosure and open to check for the presence of water. Any intrusion of water in the compartment containing the splices constitutes a failure.

678.2.2 Fiber Optic Terminations

- (1) Furnish fiber optic connectors from the department's approved products list.
- (2) Connectors shall be type ST.
- (3) Connectors shall utilize epoxy or hot melt adhesive and shall include a ceramic ferrule.

678.2.3 Communication System Testing

- (1) Supply all materials and equipment necessary to perform the tests as described in these specifications. All test equipment will remain property of the contractor. Use equipment consisting of, but not limited to, the following:
 - Optical time domain reflectometer (OTDR).
 - Optical source/power meter.
 - Patch cabling.
 - OTDR software.

678.3 Construction

678.3.1 Fiber Optic Cable

- (1) Install all cables into the conduit using a flat woven pull tape. Optionally, install the cable via forced air and a track pushing mechanism. Do not use a single pull tape for more than a single cable pull. Install the pull tape and fiber optic cables according to the testing procedures completed for this project and the pull tape and cable manufacturer's recommendations.
- (2) Install all cable according to Siecor recommended procedure SRP 005-011 for fiber optic cable placing - duct. Follow these procedures regardless of the manufacturer of the cable. If the cable manufacturer recommends an operation in conflict with these procedures, submit a request for installation procedure change to the department for approval. Do not exceed a maximum pulling tension of 608 pounds-force (2700 N) during installation and 200 pounds-force (890 N) after installation.
- (3) If the total loss exceeds the allowable loss specified under [678.3.4](#), replace or repair that cable run. If elevated attenuation due to exceeding the pulling tension during installation is determined, replace that cable run.

678.3.2 Fiber Optic Splices

- (1) Use only fusion splicing for all splices. Ensure that each splice does not exceed the attenuation limits set forth in [678.3.4](#).
- (2) Do not make mechanical splices.
- (3) Protect each splice in a protective sleeve and secure in the splice tray. Protect bare fibers with a heat-shrink coating before placement in a sleeve or housing. Install the heat-shrink coating in to protect the fiber from scoring, dirt, accumulation, moisture intrusion, and micro bending.

- (4) Install the fiber optic splice enclosure according to the manufacturer's recommended guidelines.
- (5) Perform end-to-end splicing according to the manufacturer's instructions for the supplied splice enclosure units.
- (6) Perform mid-span splicing, drop splicing, for each device location at locations the plans show. Splice according to Siecor recommended procedure SRP-004-013 for mid-span access of fiber optic cable with cable slack present, or appropriate manufacturer instructions. Contain all mid-span splices within enclosures.
- (7) Do not deviate from the splice details as the plans show without the engineer's approval.

678.3.3 Fiber Optic Terminations

- (1) Install type ST connectors to the fiber optic cable.
- (2) Terminate all fibers on the rear of the connector panel with type ST connectors.
- (3) Install fiber optic jumpers of sufficient length to connect the front side of the connector panel to the fiber equipment contained within the cabinet.
- (4) Ensure that each termination does not exceed the attenuation limits specified in [678.3.4](#).

678.3.4 Communication System Testing

- (1) Perform all communication system testing using certified fiber optic technicians approved under [670.3.2.2](#).
- (2) Provide the date, time, and location of required tests to the engineer at least 24 hours before performing the test.
- (3) After completing cable installation, splicing, and termination, test all fibers for continuity, events losses, and total attenuation of the cable as follows:
 1. Test each individual fiber for event losses using an OTDR. Conduct the test using the standard operating procedure as defined by the manufacturer of the test equipment.
 2. Connect the OTDR and the cable with a factory patch cord of a length equal to the dead zone of the OTDR. Optionally, the technician can use a factory fiber box of 325 feet (100 m) minimum with no splices within the box.
 3. Test each individual fiber for total segment attenuation loss using an optical source/power meter. Conduct the test using the standard operating procedure as defined by the manufacturer of the test equipment.
 4. Conduct both tests, OTDR and optical source/power meter, at 1310 nm and 1550 nm for each fiber in the cable.
 5. Conduct both tests bi-directionally for each fiber in the cable.
- (4) After completing the tests, submit 5 hard copies of the test results to the engineer documenting the following test parameters:

Operator name	Setup parameters	Pulse width OTDR	Range OTDR
Date and time	Wavelength	Refractory index OTDR	Scale OTDR

- (5) Summarize the results of both the OTDR and optical source/power meter tests in spreadsheet/tabular format adhering to the following requirements:
 - List fiber optic segment name including route, start point, and end point.
 - List all fibers by number.
 - List direction of test as NB, SB, EB, or WB.
 - List total fiber optic cable length for each fiber as documented in the OTDR test.
 - List attenuation in dB of gain or loss for each fiber optic event in the OTDR test.
 - List fiber optic loss event descriptions and locations including splices, miscellaneous events, and terminations.
 - List the attenuation across the cable in dB/mile for each fiber tested.
 - List the total segment loss for each fiber as determined by the optical source/power meter test.
 - Provide bi-directional data including event distances, event descriptions, and attenuation losses for each fiber corresponding to a common start point
 - Provide bi-directional data on separate lines, side-by-side within the same sheet.
 - Provide 1310 nm and 1550 nm test results on separate sheets in identical formats.

- (6) Provide copies of the fiber cable traces taken during the OTDR test to the department on diskette for review. Provide electronic files in a universal file format, or with software to view the files.
- (7) Ensure that test results demonstrate that the dB/mile loss does not exceed plus 3 percent of the factory test or plus one percent of the cable's published production loss. The department will consider the error rate for the test equipment in evaluating results.
- (8) Event losses are an average for each direction tested, and are limited to the following:

EVENT TYPE	ALLOWABLE LOSS
Fusion Splicing	0.10 dB
ST Connector	0.50 dB
Other miscellaneous events	0.10 dB
Total loss across the cable ^[1]	1 dB/mile (0.62 dB/km)

^[1] Including events and cable attenuation.

678.4 Measurement

- (1) The department will measure the Install Fiber Optic Cable Outdoor Plant bid items by the linear foot acceptably completed.
- (2) The department will measure Fiber Optic Splice Enclosure and Fiber Optic Splice as each fiber strand acceptably spliced and completed.
- (3) The department will measure Fiber Optic Termination as each fiber termination acceptably completed.
- (4) The department will measure Communication System Testing as a single lump sum unit for each service acceptably completed.

678.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
678.0000 - 0199	Install Fiber Optic Cable Outdoor Plant (count)	LF
678.0200	Fiber Optic Splice Enclosure	EACH
678.0300	Fiber Optic Splice	EACH
678.0400	Fiber Optic Termination	EACH
678.0500	Communication System Testing	LS

- (2) Payment for the Install Fiber Optic Cable Outdoor Plant bid items is full compensation for providing and testing the cabling.
- (3) Payment for Fiber Optic Splice Enclosure and Fiber Optic Splice is full compensation for all work required under the individual bid items.
- (4) Payment for Fiber Optic Termination is full compensation for installing the terminations, termination panel, connectors, and jumper cables.
- (5) Payment for Communication System Testing is full compensation for furnishing testing and all documentation and certifications of testing necessary.
- (6) The department will not pay for replacements or repairs required under [678.3.1](#).

SECTION 690 SAWING PAVEMENT

690.1 Description

- (1) This section describes partial-depth or full-depth sawing of existing concrete or asphaltic pavement or surfacing, curb & gutter, driveways, sidewalks, and similar work.

690.2 (Vacant)

690.3 Construction

690.3.1 Equipment

- (1) Use diamond blades for sawing concrete pavement full-depth. The contractor may use carbide-cutting wheels to saw concrete pavement that will be overlaid or for full-depth concrete pavement repairs where the cut face does not join the new pavement.

690.3.2 Sawing Existing Pavement

- (1) Make straight saw cuts at least 2 inches (50 mm) deep. Saw so the surface remaining is generally vertical over its full depth.

690.3.3 Sawing Concrete Pavement Full-Depth

- (1) Do not extend saw cuts into newly placed concrete pavement or into existing pavements more than 12 inches (300 mm) beyond the limits the engineer designates.
- (2) Remove sawing sludge after completing each saw cut. Minimize sludge on live traffic lanes. Remove sludge from all traffic control devices each day before dark. Dispose of sludge at an acceptable material disposal site or on engineer-approved areas of the roadway or roadside.

690.4 Measurement

- (1) The department will measure Sawing Existing Pavement and Sawing Concrete Pavement Full Depth by the linear foot acceptably completed. The department will not measure overcuts beyond the limits the plans show or the engineer directs.
- (2) If performing Sawing Concrete Pavement Full Depth in conjunction with the bid items Concrete Pavement Repair SHES, Concrete Pavement Repair, or Base Patching Concrete SHES, the department will measure the applicable total quantity of the following:
1. One full-depth longitudinal cut through the repair area if the engineer deems that cut necessary.
 2. Two transverse cuts, one at each limit of the repair area.
 3. Additional full-depth transverse cuts necessary to reduce the removal slabs to a transportable size. The department will not measure cuts made to reduce removal slabs to a width less than 7 feet (2 m).
 4. Additional cuts the engineer directs to extend the repair limits, unless those cuts were required because of damage contractor operations caused.

690.5 Payment

- (1) The department will pay for measured quantities at the contract unit price under the following bid items:

<u>ITEM NUMBER</u>	<u>DESCRIPTION</u>	<u>UNIT</u>
690.0100	Sawing Existing Pavement	LF
690.0200	Sawing Concrete Pavement Full Depth	LF

- (2) Payment is full compensation for all sawing and sludge removal.

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
108.4300	RBC Progress Schedule	EACH
108.4400	CPM Progress Schedule	EACH
201.0105	Clearing	STA
201.0110	Clearing	SY
201.0115	Clearing	ACRE
201.0120	Clearing	ID
201.0205	Grubbing	STA
201.0210	Grubbing	SY
201.0215	Grubbing	ACRE
201.0220	Grubbing	ID
202.0105	Roadside Clearing (station)	STA
202.0110	Roadside Clearing	SY
202.0115	Roadside Clearing	ACRE
203.0100	Removing Small Pipe Culverts	EACH
203.0200	Removing Old Structure (station)	LS
204.0100	Removing Pavement	SY
204.0105	Removing Pavement Butt Joints	SY
204.0110	Removing Asphaltic Surface	SY
204.0115	Removing Asphaltic Surface Butt Joints	SY
204.0120	Removing Asphaltic Surface Milling	SY
204.0125	Removing Asphaltic Surface Milling	TON
204.0130	Removing Curb	LF
204.0140	Removing Gutter	LF
204.0150	Removing Curb & Gutter	LF
204.0155	Removing Concrete Sidewalk	SY
204.0160	Removing Lip Curb	LF
204.0165	Removing Guardrail	LF
204.0170	Removing Fence	LF
204.0175	Removing Concrete Slope Paving	SY
204.0180	Removing Marker Posts	EACH
204.0185	Removing Masonry	CY
204.0190	Removing Surface Drains	EACH
204.0195	Removing Concrete Bases	EACH
204.0200	Removing Railroad Track	LF
204.0205	Removing Utility Poles	EACH
204.0210	Removing Manholes	EACH
204.0215	Removing Catch Basins	EACH
204.0220	Removing Inlets	EACH
204.0225	Removing Septic Tanks	EACH
204.0230	Removing Building (station)	LS
204.0235	Removing Buildings (parcel)	LS
204.0240	Site Clearance (parcel)	LS
204.0245	Removing Storm Sewer (size)	LF
204.0250	Abandoning Manholes	EACH
204.0255	Abandoning Catch Basins	EACH
204.0260	Abandoning Inlets	EACH
204.0265	Abandoning Wells	EACH
204.0270	Abandoning Culvert Pipes	EACH
204.0275	Closing Culvert Pipes	EACH
204.0280	Sealing Pipes	EACH
205.0100	Excavation Common	CY
205.0200	Excavation Rock	CY
205.0300	Excavation Stone Piles and Stone Fences	CY
205.0400	Excavation Marsh	CY
205.1200	Overhaul	YDMI

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
205.1300	Presplitting Rock	LF
206.1000	Excavation for Structures Bridges (structure)	LS
206.2000	Excavation for Structures Culverts (structure)	LS
206.3000	Excavation for Structures Retaining Walls (structure)	LS
206.4000	Excavation for Structures Structural Plate Pipe or Pipe Arches (station)	LS
206.5000	Cofferdams (structure)	LS
208.0100	Borrow	CY
208.1100	Select Borrow	CY
209.0100	Backfill Granular	CY
210.0100	Backfill Structure	CY
211.0100	Prepare Foundation for Asphaltic Paving (project)	LS
211.0200	Prepare Foundation for Concrete Pavement (project)	LS
211.0300	Prepare Foundation for Concrete Base (project)	LS
211.0400	Prepare Foundation for Asphaltic Shoulders	STA
211.0500	Prepare Foundation for Base Aggregate	STA
213.0100	Finishing Roadway (project)	EACH
214.0100	Obliterating Old Road	STA
305.0110	Base Aggregate Dense 3/4-Inch	TON
305.0115	Base Aggregate Dense 3/4-Inch	CY
305.0120	Base Aggregate Dense 1 1/4-Inch	TON
305.0125	Base Aggregate Dense 1 1/4-Inch	CY
305.0130	Base Aggregate Dense 3-Inch	TON
305.0135	Base Aggregate Dense 3-Inch	CY
305.0410	Aggregate Detours	TON
305.0415	Aggregate Detours	CY
305.0500	Shaping Shoulders	STA
306.0110	Salvaged Asphaltic Pavement Base	TON
306.0115	Salvaged Asphaltic Pavement Base	CY
310.0110	Base Aggregate Open Graded	TON
310.0115	Base Aggregate Open Graded	CY
311.0110	Breaker Run	TON
311.0115	Breaker Run	CY
312.0110	Select Crushed Material	TON
312.0115	Select Crushed Material	CY
313.0110	Pit Run	TON
313.0115	Pit Run	CY
315.0100	Asphaltic Base	TON
315.0200	Asphaltic Base Widening	TON
320.0105	Concrete Base 4-Inch	SY
320.0110	Concrete Base 4 1/2-Inch	SY
320.0115	Concrete Base 5-Inch	SY
320.0120	Concrete Base 5 1/2-Inch	SY
320.0125	Concrete Base 6-Inch	SY
320.0130	Concrete Base 6 1/2-Inch	SY
320.0135	Concrete Base 7-Inch	SY
320.0140	Concrete Base 7 1/2-Inch	SY
320.0145	Concrete Base 8-Inch	SY
320.0150	Concrete Base 8 1/2-Inch	SY
320.0155	Concrete Base 9-Inch	SY
320.0160	Concrete Base 9 1/2-Inch	SY
320.0165	Concrete Base 10-Inch	SY
320.0170	Concrete Base 10 1/2-Inch	SY
320.0305	Concrete Base HES 4-Inch	SY
320.0310	Concrete Base HES 4 1/2-Inch	SY
320.0315	Concrete Base HES 5-Inch	SY
320.0320	Concrete Base HES 5 1/2-Inch	SY

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
320.0325	Concrete Base HES 6-Inch	SY
320.0330	Concrete Base HES 6 1/2-Inch	SY
320.0335	Concrete Base HES 7-Inch	SY
320.0340	Concrete Base HES 7 1/2-Inch	SY
320.0345	Concrete Base HES 8-Inch	SY
320.0350	Concrete Base HES 8 1/2-Inch	SY
320.0355	Concrete Base HES 9-Inch	SY
320.0360	Concrete Base HES 9 1/2-Inch	SY
320.0365	Concrete Base HES 10-Inch	SY
320.0370	Concrete Base HES 10 1/2-Inch	SY
320.0500	Concrete Base Widening	SY
325.0100	Pulverize and Relay	SY
330.0100	Mill and Relay	SY
335.0100	Rubblizing	SY
340.0100	Cracking and Seating	SY
350.0102	Subbase	CY
350.0104	Subbase	TON
350.0115	Subbase 6-Inch	SY
350.0120	Subbase 7-Inch	SY
350.0125	Subbase 8-Inch	SY
350.0130	Subbase 9-Inch	SY
350.0135	Subbase 10-Inch	SY
350.0140	Subbase 11-Inch	SY
350.0145	Subbase 12-Inch	SY
390.0101	Base Patching	TON
390.0103	Base Patching	SY
390.0201	Base Patching Asphaltic	TON
390.0203	Base Patching Asphaltic	SY
390.0301	Base Patching Concrete	TON
390.0303	Base Patching Concrete	SY
390.0403	Base Patching Concrete SHES	SY
415.0060	Concrete Pavement 6-Inch	SY
415.0065	Concrete Pavement 6 1/2-Inch	SY
415.0070	Concrete Pavement 7-Inch	SY
415.0075	Concrete Pavement 7 1/2-Inch	SY
415.0080	Concrete Pavement 8-Inch	SY
415.0085	Concrete Pavement 8 1/2-Inch	SY
415.0090	Concrete Pavement 9-Inch	SY
415.0095	Concrete Pavement 9 1/2-Inch	SY
415.0100	Concrete Pavement 10-Inch	SY
415.0105	Concrete Pavement 10 1/2-Inch	SY
415.0110	Concrete Pavement 11-Inch	SY
415.0115	Concrete Pavement 11 1/2-Inch	SY
415.0120	Concrete Pavement 12-Inch	SY
415.1080	Concrete Pavement HES 8-Inch	SY
415.1085	Concrete Pavement HES 8 1/2 Inch	SY
415.1090	Concrete Pavement HES 9-Inch	SY
415.1095	Concrete Pavement HES 9 1/2 Inch	SY
415.1100	Concrete Pavement HES 10-Inch	SY
415.1105	Concrete Pavement HES 10 1/2 Inch	SY
415.1110	Concrete Pavement HES 11-Inch	SY
415.1115	Concrete Pavement HES 11 1/2 Inch	SY
415.1120	Concrete Pavement HES 12-Inch	SY
415.5105	Concrete Pavement Continuous Reinforcement	SY
416.0050	Concrete Pavement Approach Slab	SY
416.0055	Concrete Pavement Approach Slab HES	SY

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
416.0060	Concrete Pavement Widening	SY
416.0065	Concrete Pavement Widening HES	SY
416.0160	Concrete Driveway 6-Inch	SY
416.0170	Concrete Driveway 7-Inch	SY
416.0180	Concrete Driveway 8-Inch	SY
416.0190	Concrete Driveway 9-Inch	SY
416.0260	Concrete Driveway HES 6-Inch	SY
416.0270	Concrete Driveway HES 7-Inch	SY
416.0280	Concrete Driveway HES 8-Inch	SY
416.0290	Concrete Driveway HES 9-Inch	SY
416.0310	Concrete Alley	SY
416.0315	Concrete Alley HES	SY
416.0410	Concrete Pavement Header	SY
416.0415	Concrete Pavement Header HES	SY
416.0505	Pavement Terminal Units	EACH
416.0610	Pavement Ties	EACH
416.0620	Pavement Dowel Bars	EACH
416.0710	Concrete Pavement Repair	CY
416.0715	Concrete Pavement Repair SHES	CY
416.0805	Concrete Pavement Gaps	EACH
416.0905	Concrete Pavement Continuous Diamond Grinding	SY
416.1010	Concrete Surface Drains	CY
416.1015	Concrete Surface Drains HES	CY
455.0105	Asphaltic Material PG58-28	TON
455.0110	Asphaltic Material PG58-34	TON
455.0115	Asphaltic Material PG64-22	TON
455.0120	Asphaltic Material PG64-28	TON
455.0125	Asphaltic Material PG70-28	TON
455.0205	Asphaltic Material PG58-28	GAL
455.0210	Asphaltic Material PG58-34	GAL
455.0215	Asphaltic Material PG64-22	GAL
455.0220	Asphaltic Material PG64-28	GAL
455.0225	Asphaltic Material PG70-28	GAL
455.0300	Asphaltic Material Special	TON
455.0400	Asphaltic Material Special	GAL
455.0500	Asphaltic Material Seal Coat	TON
455.0505	Asphaltic Material Seal Coat	GAL
455.0600	Tack Coat	TON
455.0605	Tack Coat	GAL
460.1100	HMA Pavement Type E-0.3	TON
460.1101	HMA Pavement Type E-1	TON
460.1103	HMA Pavement Type E-3	TON
460.1110	HMA Pavement Type E-10	TON
460.1130	HMA Pavement Type E-30	TON
460.1132	HMA Pavement Type E-30X	TON
460.1700	HMA Pavement Type SMA	TON
460.2000	Incentive Density HMA Pavement	DOL
460.3000	QMP HMA Mixture	TON
465.0105	Asphaltic Surface	TON
465.0110	Asphaltic Surface Patching	TON
465.0115	Asphaltic Surface Detours	TON
465.0120	Asphaltic Surface Driveways and Field Entrances	TON
465.0125	Asphaltic Surface Temporary	TON
465.0305	Asphaltic Surface Safety Islands	TON
465.0310	Asphaltic Curb	LF
465.0315	Asphaltic Flumes	SY

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
465.0400	Asphaltic Shoulder Rumble Strip	LF
465.0450	Asphaltic Intersection Rumble Strip	SY
475.0100	Seal Coat	CY
475.0105	Seal Coat	TON
490.0100	Salvaged Asphaltic Pavement	SY
490.0105	Salvaged Asphaltic Pavement	TON
490.0200	Salvaged Asphaltic Pavement Milling	SY
490.0205	Salvaged Asphaltic Pavement Milling	TON
502.0100	Concrete Masonry Bridges	CY
502.0200	Concrete Masonry Bridges HES	CY
502.1100	Concrete Masonry Seal	CY
502.2000	Compression Joint Sealer Preformed Elastomeric (width)	LF
502.3100	Expansion Device (structure)	LS
502.3200	Protective Surface Treatment	SY
502.5002	Masonry Anchors Type L No. 4 Bars	EACH
502.5005	Masonry Anchors Type L No. 5 Bars	EACH
502.5010	Masonry Anchors Type L No. 6 Bars	EACH
502.5015	Masonry Anchors Type L No. 7 Bars	EACH
502.5020	Masonry Anchors Type L No. 8 Bars	EACH
502.5025	Masonry Anchors Type L No. 9 Bars	EACH
502.6102	Masonry Anchors Type S 1/2-Inch	EACH
502.6105	Masonry Anchors Type S 5/8-Inch	EACH
502.6110	Masonry Anchors Type S 3/4-Inch	EACH
502.6115	Masonry Anchors Type S 7/8-Inch	EACH
502.6120	Masonry Anchors Type S 1-Inch	EACH
502.6500	Protective Coating Clear	GAL
503.0128	Prestressed Girder Type I 28-Inch	LF
503.0136	Prestressed Girder Type I 36-Inch	LF
503.0145	Prestressed Girder Type I 45-Inch	LF
503.0154	Prestressed Girder Type I 54-Inch	LF
503.0155	Prestressed Girder Type I 54W-Inch	LF
503.0170	Prestressed Girder Type I 70-Inch	LF
503.0172	Prestressed Girder Type I 72W-Inch	LF
503.0217	Prestressed Girder Box Type 17-Inch	LF
503.0221	Prestressed Girder Box Type 21-Inch	LF
503.0227	Prestressed Girder Box Type 27-Inch	LF
503.0233	Prestressed Girder Box Type 33-Inch	LF
503.0242	Prestressed Girder Box Type 42-Inch	LF
503.0312	Prestressed Girder Slab Type 12-Inch	LF
504.0100	Concrete Masonry Culverts	CY
504.0200	Concrete Masonry Culverts HES	CY
504.0500	Concrete Masonry Retaining Walls	CY
504.0600	Concrete Masonry Retaining Walls HES	CY
504.0900	Concrete Masonry Endwalls	CY
505.0105	Bar Steel Reinforcement Bridges	LB
505.0110	Bar Steel Reinforcement Culverts	LB
505.0115	Bar Steel Reinforcement Retaining Walls	LB
505.0405	Bar Steel Reinforcement HS Bridges	LB
505.0410	Bar Steel Reinforcement HS Culverts	LB
505.0415	Bar Steel Reinforcement HS Retaining Walls	LB
505.0605	Bar Steel Reinforcement HS Coated Bridges	LB
505.0610	Bar Steel Reinforcement HS Coated Culverts	LB
505.0615	Bar Steel Reinforcement HS Coated Retaining Walls	LB
506.0105	Structural Steel Carbon	LB
506.0605	Structural Steel HS	LB
506.1005	Castings Steel	LB

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
506.1010	Castings Bronze	LB
506.1105	Forgings Steel Carbon	LB
506.1405	Lubricated Plates Bronze	LB
506.1505	Sheet Copper	LB
506.1510	Sheet Zinc	LB
506.2105	Bearing Pads	SF
506.2605	Bearing Pads Elastomeric Non-Laminated	EACH
506.2610	Bearing Pads Elastomeric Laminated	EACH
506.3005	Welded Stud Shear Connectors 7/8x4-Inch	EACH
506.3010	Welded Stud Shear Connectors 7/8x5-Inch	EACH
506.3015	Welded Stud Shear Connectors 7/8x6-Inch	EACH
506.3020	Welded Stud Shear Connectors 7/8x7-Inch	EACH
506.3025	Welded Stud Shear Connectors 7/8x8-Inch	EACH
506.4000	Steel Diaphragms (structure)	EACH
506.5000	Bearing Assemblies Fixed (structure)	EACH
506.6000	Bearing Assemblies Expansion (structure)	EACH
507.0200	Treated Lumber and Timber	MBM
508.0100	Piling Test Untreated Timber (structure)	LS
508.1000	Piling Untreated Timber Delivered	LF
508.1300	Piling Untreated Timber Driven	LF
508.1600	Piling Treated Timber Delivered	LF
508.2000	Piling Treated Timber Driven	LF
508.3000	Piling Test Treated Timber (structure)	LS
508.4000	Preboring Timber Piling	LF
509.0200	Preparation Approaches	SY
509.0301	Preparation Decks Type 1	SY
509.0302	Preparation Decks Type 2	SY
509.0500	Cleaning Decks	SY
509.0600	Cleaning Approaches	SY
509.1000	Joint Repair	SY
509.1200	Curb Repair	LF
509.1500	Concrete Surface Repair	SF
509.2000	Full-Depth Deck Repair	SY
509.2500	Concrete Masonry Overlay Decks	CY
509.2600	Concrete Masonry Overlay Approaches	CY
510.2005	Preboring CIP Concrete Piling	LF
510.3010	Piling CIP Concrete Delivered and Driven 10 3/4-Inch	LF
510.3012	Piling CIP Concrete Delivered and Driven 12-Inch	LF
510.3014	Piling CIP Concrete Delivered and Driven 14-Inch	LF
510.3016	Piling CIP Concrete Delivered and Driven 16-Inch	LF
511.2105	Piling Steel Delivered and Driven HP 10-Inch x 42 LB	LF
511.2110	Piling Steel Delivered and Driven HP 12-Inch x 53 LB	LF
511.2115	Piling Steel Delivered and Driven HP 12-Inch x 74 LB	LF
511.2120	Piling Steel Delivered and Driven HP 14-Inch x 73 LB	LF
511.3000	Pile Points	EACH
512.0500	Piling Steel Sheet Permanent Delivered	SF
512.0600	Piling Steel Sheet Permanent Driven	SF
512.1000	Piling Steel Sheet Temporary	SF
513.2000	Railing Pipe (structure)	LS
513.4050	Railing Tubular Type F (structure)	LS
513.4052	Railing Tubular Type F-4 Modified (structure)	LS
513.4053	Railing Tubular Type F-5 Modified (structure)	LS
513.4055	Railing Tubular Type H (structure)	LS
513.4060	Railing Tubular Type M (structure)	LS
513.4065	Railing Tubular Type PF (structure)	LS
513.4080	Railing Tubular Special (structure)	LS

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
513.4090	Railing Tubular Screening (structure)	LS
513.6000	Railing Steel (structure)	LS
513.7005	Railing Steel Type C1 (structure)	LS
513.7010	Railing Steel Type C2 (structure)	LS
513.7015	Railing Steel Type C3 (structure)	LS
513.7020	Railing Steel Type C4 (structure)	LS
513.7025	Railing Steel Type C5 (structure)	LS
513.7030	Railing Steel Type C6 (structure)	LS
513.7050	Railing Steel Type W (structure)	LS
513.7090	Railing Steel Special (structure)	LS
514.0440	Floor Drains Type G	EACH
514.0445	Floor Drains Type GC	EACH
514.0460	Floor Drains Type H	EACH
514.0900	Adjusting Floor Drains	EACH
514.1000	Deck Drains (structure)	LS
514.2625	Downspout 6-Inch	LF
515.4000	Steel Grid Floor Open (inch)	SF
515.5000	Steel Grid Floor Concrete Filled (inch)	SF
516.0100	Dampproofing	SY
516.0500	Rubberized Membrane Waterproofing	SY
517.0600	Painting Epoxy System (structure)	LS
518.0100	Rubble Masonry Mortar	CY
518.0200	Rubble Masonry Dry	CY
520.0112	Culvert Pipe Class III 12-Inch	LF
520.0115	Culvert Pipe Class III 15-Inch	LF
520.0118	Culvert Pipe Class III 18-Inch	LF
520.0121	Culvert Pipe Class III 21-Inch	LF
520.0124	Culvert Pipe Class III 24-Inch	LF
520.0130	Culvert Pipe Class III 30-Inch	LF
520.0136	Culvert Pipe Class III 36-Inch	LF
520.0142	Culvert Pipe Class III 42-Inch	LF
520.0148	Culvert Pipe Class III 48-Inch	LF
520.0154	Culvert Pipe Class III 54-Inch	LF
520.0160	Culvert Pipe Class III 60-Inch	LF
520.0172	Culvert Pipe Class III 72-Inch	LF
520.0184	Culvert Pipe Class III 84-Inch	LF
520.0312	Culvert Pipe Class IV 12-Inch	LF
520.0315	Culvert Pipe Class IV 15-Inch	LF
520.0318	Culvert Pipe Class IV 18-Inch	LF
520.0321	Culvert Pipe Class IV 21-Inch	LF
520.0324	Culvert Pipe Class IV 24-Inch	LF
520.0330	Culvert Pipe Class IV 30-Inch	LF
520.0336	Culvert Pipe Class IV 36-Inch	LF
520.0342	Culvert Pipe Class IV 42-Inch	LF
520.0348	Culvert Pipe Class IV 48-Inch	LF
520.0354	Culvert Pipe Class IV 54-Inch	LF
520.0360	Culvert Pipe Class IV 60-Inch	LF
520.0372	Culvert Pipe Class IV 72-Inch	LF
520.0384	Culvert Pipe Class IV 84-Inch	LF
520.0612	Culvert Pipe Class V 12-Inch	LF
520.0615	Culvert Pipe Class V 15-Inch	LF
520.0618	Culvert Pipe Class V 18-Inch	LF
520.0621	Culvert Pipe Class V 21-Inch	LF
520.0624	Culvert Pipe Class V 24-Inch	LF
520.0630	Culvert Pipe Class V 30-Inch	LF
520.0636	Culvert Pipe Class V 36-Inch	LF

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
520.0642	Culvert Pipe Class V 42-Inch	LF
520.0648	Culvert Pipe Class V 48-Inch	LF
520.0654	Culvert Pipe Class V 54-Inch	LF
520.0660	Culvert Pipe Class V 60-Inch	LF
520.0672	Culvert Pipe Class V 72-Inch	LF
520.0684	Culvert Pipe Class V 84-Inch	LF
520.1012	Apron Endwalls for Culvert Pipe 12-Inch	EACH
520.1015	Apron Endwalls for Culvert Pipe 15-Inch	EACH
520.1018	Apron Endwalls for Culvert Pipe 18-Inch	EACH
520.1021	Apron Endwalls for Culvert Pipe 21-Inch	EACH
520.1024	Apron Endwalls for Culvert Pipe 24-Inch	EACH
520.1030	Apron Endwalls for Culvert Pipe 30-Inch	EACH
520.1036	Apron Endwalls for Culvert Pipe 36-Inch	EACH
520.1042	Apron Endwalls for Culvert Pipe 42-Inch	EACH
520.1048	Apron Endwalls for Culvert Pipe 48-Inch	EACH
520.1054	Apron Endwalls for Culvert Pipe 54-Inch	EACH
520.1060	Apron Endwalls for Culvert Pipe 60-Inch	EACH
520.1072	Apron Endwalls for Culvert Pipe 72-Inch	EACH
520.1084	Apron Endwalls for Culvert Pipe 84-Inch	EACH
520.4012	Culvert Pipe Temporary 12-Inch	LF
520.4015	Culvert Pipe Temporary 15-Inch	LF
520.4018	Culvert Pipe Temporary 18-Inch	LF
520.4021	Culvert Pipe Temporary 21-Inch	LF
520.4024	Culvert Pipe Temporary 24-Inch	LF
520.4030	Culvert Pipe Temporary 30-Inch	LF
520.4036	Culvert Pipe Temporary 36-Inch	LF
520.4042	Culvert Pipe Temporary 42-Inch	LF
520.4048	Culvert Pipe Temporary 48-Inch	LF
520.4054	Culvert Pipe Temporary 54-Inch	LF
520.4060	Culvert Pipe Temporary 60-Inch	LF
520.4072	Culvert Pipe Temporary 72-Inch	LF
520.4084	Culvert Pipe Temporary 84-Inch	LF
520.5000	Pipe Cattle Pass	LF
520.7000	Cleaning Culvert Pipes	EACH
521.0112	Culvert Pipe Corrugated Steel 12-Inch	LF
521.0115	Culvert Pipe Corrugated Steel 15-Inch	LF
521.0118	Culvert Pipe Corrugated Steel 18-Inch	LF
521.0121	Culvert Pipe Corrugated Steel 21-Inch	LF
521.0124	Culvert Pipe Corrugated Steel 24-Inch	LF
521.0130	Culvert Pipe Corrugated Steel 30-Inch	LF
521.0136	Culvert Pipe Corrugated Steel 36-Inch	LF
521.0142	Culvert Pipe Corrugated Steel 42-Inch	LF
521.0148	Culvert Pipe Corrugated Steel 48-Inch	LF
521.0154	Culvert Pipe Corrugated Steel 54-Inch	LF
521.0160	Culvert Pipe Corrugated Steel 60-Inch	LF
521.0172	Culvert Pipe Corrugated Steel 72-Inch	LF
521.0184	Culvert Pipe Corrugated Steel 84-Inch	LF
521.0196	Culvert Pipe Corrugated Steel 96-Inch	LF
521.0336	Apron Endwalls for Culvert Pipe Sloped Cross Drains Steel 36-Inch	EACH
521.0342	Apron Endwalls for Culvert Pipe Sloped Cross Drains Steel 42-Inch	EACH
521.0348	Apron Endwalls for Culvert Pipe Sloped Cross Drains Steel 48-Inch	EACH
521.0354	Apron Endwalls for Culvert Pipe Sloped Cross Drains Steel 54-Inch	EACH
521.0360	Apron Endwalls for Culvert Pipe Sloped Cross Drains Steel 60-Inch	EACH
521.0542	Apron Endwalls for Pipe Arch Sloped Cross Drains Steel 42x29-Inch	EACH
521.0549	Apron Endwalls for Pipe Arch Sloped Cross Drains Steel 49x33-Inch	EACH
521.0557	Apron Endwalls for Pipe Arch Sloped Cross Drains Steel 57x38-Inch	EACH

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
521.0564	Apron Endwalls for Pipe Arch Sloped Cross Drains Steel 64x43-Inch	EACH
521.0571	Apron Endwalls for Pipe Arch Sloped Cross Drains Steel 71x47-Inch	EACH
521.0717	Pipe Arch Corrugated Steel 17x13-Inch	LF
521.0721	Pipe Arch Corrugated Steel 21x15-Inch	LF
521.0724	Pipe Arch Corrugated Steel 24x18-Inch	LF
521.0728	Pipe Arch Corrugated Steel 28x20-Inch	LF
521.0735	Pipe Arch Corrugated Steel 35x24-Inch	LF
521.0742	Pipe Arch Corrugated Steel 42x29-Inch	LF
521.0749	Pipe Arch Corrugated Steel 49x33-Inch	LF
521.0757	Pipe Arch Corrugated Steel 57x38-Inch	LF
521.0764	Pipe Arch Corrugated Steel 64x43-Inch	LF
521.0771	Pipe Arch Corrugated Steel 71x47-Inch	LF
521.0777	Pipe Arch Corrugated Steel 77x52-Inch	LF
521.0783	Pipe Arch Corrugated Steel 83x57-Inch	LF
521.1012	Apron Endwalls for Culvert Pipe Steel 12-Inch	EACH
521.1015	Apron Endwalls for Culvert Pipe Steel 15-Inch	EACH
521.1018	Apron Endwalls for Culvert Pipe Steel 18-Inch	EACH
521.1021	Apron Endwalls for Culvert Pipe Steel 21-Inch	EACH
521.1024	Apron Endwalls for Culvert Pipe Steel 24-Inch	EACH
521.1030	Apron Endwalls for Culvert Pipe Steel 30-Inch	EACH
521.1036	Apron Endwalls for Culvert Pipe Steel 36-Inch	EACH
521.1042	Apron Endwalls for Culvert Pipe Steel 42-Inch	EACH
521.1048	Apron Endwalls for Culvert Pipe Steel 48-Inch	EACH
521.1054	Apron Endwalls for Culvert Pipe Steel 54-Inch	EACH
521.1060	Apron Endwalls for Culvert Pipe Steel 60-Inch	EACH
521.1072	Apron Endwalls for Culvert Pipe Steel 72-Inch	EACH
521.1084	Apron Endwalls for Culvert Pipe Steel 84-Inch	EACH
521.1217	Apron Endwalls for Pipe Arch Steel 17x13-Inch	EACH
521.1221	Apron Endwalls for Pipe Arch Steel 21x15-Inch	EACH
521.1224	Apron Endwalls for Pipe Arch Steel 24x18-Inch	EACH
521.1228	Apron Endwalls for Pipe Arch Steel 28x20-Inch	EACH
521.1235	Apron Endwalls for Pipe Arch Steel 35x24-Inch	EACH
521.1242	Apron Endwalls for Pipe Arch Steel 42x29-Inch	EACH
521.1249	Apron Endwalls for Pipe Arch Steel 49x33-Inch	EACH
521.1257	Apron Endwalls for Pipe Arch Steel 57x38-Inch	EACH
521.1264	Apron Endwalls for Pipe Arch Steel 64x43-Inch	EACH
521.1271	Apron Endwalls for Pipe Arch Steel 71x47-Inch	EACH
521.1277	Apron Endwalls for Pipe Arch Steel 77x52-Inch	EACH
521.1283	Apron Endwalls for Pipe Arch Steel 83x57-Inch	EACH
521.1515	Apron Endwalls for Culvert Pipe Sloped Section Steel 15-Inch	EACH
521.1518	Apron Endwalls for Culvert Pipe Sloped Section Steel 18-Inch	EACH
521.1521	Apron Endwalls for Culvert Pipe Sloped Section Steel 21-Inch	EACH
521.1524	Apron Endwalls for Culvert Pipe Sloped Section Steel 24-Inch	EACH
521.1530	Apron Endwalls for Culvert Pipe Sloped Section Steel 30-Inch	EACH
521.1536	Apron Endwalls for Culvert Pipe Sloped Section Steel 36-Inch	EACH
521.1542	Apron Endwalls for Culvert Pipe Sloped Section Steel 42-Inch	EACH
521.1548	Apron Endwalls for Culvert Pipe Sloped Section Steel 48-Inch	EACH
521.1554	Apron Endwalls for Culvert Pipe Sloped Section Steel 54-Inch	EACH
521.1717	Apron Endwalls for Pipe Arch Sloped Section Steel 17x13-Inch	EACH
521.1721	Apron Endwalls for Pipe Arch Sloped Section Steel 21x15-Inch	EACH
521.1724	Apron Endwalls for Pipe Arch Sloped Section Steel 24x18-Inch	EACH
521.1728	Apron Endwalls for Pipe Arch Sloped Section Steel 28x20-Inch	EACH
521.1735	Apron Endwalls for Pipe Arch Sloped Section Steel 35x24-Inch	EACH
521.1742	Apron Endwalls for Pipe Arch Sloped Section Steel 42x29-Inch	EACH
521.1749	Apron Endwalls for Pipe Arch Sloped Section Steel 49x33-Inch	EACH
521.1757	Apron Endwalls for Pipe Arch Sloped Section Steel 57x38-Inch	EACH

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
521.1764	Apron Endwalls for Pipe Arch Sloped Section Steel 64x43-Inch	EACH
521.1900	Pipe Cattle Pass Corrugated Steel	LF
522.0112	Culvert Pipe Reinforced Concrete Class III 12-Inch	LF
522.0115	Culvert Pipe Reinforced Concrete Class III 15-Inch	LF
522.0118	Culvert Pipe Reinforced Concrete Class III 18-Inch	LF
522.0121	Culvert Pipe Reinforced Concrete Class III 21-Inch	LF
522.0124	Culvert Pipe Reinforced Concrete Class III 24-Inch	LF
522.0127	Culvert Pipe Reinforced Concrete Class III 27-Inch	LF
522.0130	Culvert Pipe Reinforced Concrete Class III 30-Inch	LF
522.0136	Culvert Pipe Reinforced Concrete Class III 36-Inch	LF
522.0142	Culvert Pipe Reinforced Concrete Class III 42-Inch	LF
522.0148	Culvert Pipe Reinforced Concrete Class III 48-Inch	LF
522.0154	Culvert Pipe Reinforced Concrete Class III 54-Inch	LF
522.0160	Culvert Pipe Reinforced Concrete Class III 60-Inch	LF
522.0166	Culvert Pipe Reinforced Concrete Class III 66-Inch	LF
522.0172	Culvert Pipe Reinforced Concrete Class III 72-Inch	LF
522.0178	Culvert Pipe Reinforced Concrete Class III 78-Inch	LF
522.0184	Culvert Pipe Reinforced Concrete Class III 84-Inch	LF
522.0190	Culvert Pipe Reinforced Concrete Class III 90-Inch	LF
522.0196	Culvert Pipe Reinforced Concrete Class III 96-Inch	LF
522.0202	Culvert Pipe Reinforced Concrete Class III 102-Inch	LF
522.0208	Culvert Pipe Reinforced Concrete Class III 108-Inch	LF
522.0312	Culvert Pipe Reinforced Concrete Class IV 12-Inch	LF
522.0315	Culvert Pipe Reinforced Concrete Class IV 15-Inch	LF
522.0318	Culvert Pipe Reinforced Concrete Class IV 18-Inch	LF
522.0321	Culvert Pipe Reinforced Concrete Class IV 21-Inch	LF
522.0324	Culvert Pipe Reinforced Concrete Class IV 24-Inch	LF
522.0327	Culvert Pipe Reinforced Concrete Class IV 27-Inch	LF
522.0330	Culvert Pipe Reinforced Concrete Class IV 30-Inch	LF
522.0336	Culvert Pipe Reinforced Concrete Class IV 36-Inch	LF
522.0342	Culvert Pipe Reinforced Concrete Class IV 42-Inch	LF
522.0348	Culvert Pipe Reinforced Concrete Class IV 48-Inch	LF
522.0354	Culvert Pipe Reinforced Concrete Class IV 54-Inch	LF
522.0360	Culvert Pipe Reinforced Concrete Class IV 60-Inch	LF
522.0366	Culvert Pipe Reinforced Concrete Class IV 66-Inch	LF
522.0372	Culvert Pipe Reinforced Concrete Class IV 72-Inch	LF
522.0378	Culvert Pipe Reinforced Concrete Class IV 78-Inch	LF
522.0384	Culvert Pipe Reinforced Concrete Class IV 84-Inch	LF
522.0512	Culvert Pipe Reinforced Concrete Class V 12-Inch	LF
522.0515	Culvert Pipe Reinforced Concrete Class V 15-Inch	LF
522.0518	Culvert Pipe Reinforced Concrete Class V 18-Inch	LF
522.0521	Culvert Pipe Reinforced Concrete Class V 21-Inch	LF
522.0524	Culvert Pipe Reinforced Concrete Class V 24-Inch	LF
522.0527	Culvert Pipe Reinforced Concrete Class V 27-Inch	LF
522.0530	Culvert Pipe Reinforced Concrete Class V 30-Inch	LF
522.0536	Culvert Pipe Reinforced Concrete Class V 36-Inch	LF
522.0542	Culvert Pipe Reinforced Concrete Class V 42-Inch	LF
522.0548	Culvert Pipe Reinforced Concrete Class V 48-Inch	LF
522.0554	Culvert Pipe Reinforced Concrete Class V 54-Inch	LF
522.0560	Culvert Pipe Reinforced Concrete Class V 60-Inch	LF
522.0566	Culvert Pipe Reinforced Concrete Class V 66-Inch	LF
522.0572	Culvert Pipe Reinforced Concrete Class V 72-Inch	LF
522.0584	Culvert Pipe Reinforced Concrete Class V 84-Inch	LF
522.1012	Apron Endwalls for Culvert Pipe Reinforced Concrete 12-Inch	EACH
522.1015	Apron Endwalls for Culvert Pipe Reinforced Concrete 15-Inch	EACH
522.1018	Apron Endwalls for Culvert Pipe Reinforced Concrete 18-Inch	EACH

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
522.1021	Apron Endwalls for Culvert Pipe Reinforced Concrete 21-Inch	EACH
522.1024	Apron Endwalls for Culvert Pipe Reinforced Concrete 24-Inch	EACH
522.1027	Apron Endwalls for Culvert Pipe Reinforced Concrete 27-Inch	EACH
522.1030	Apron Endwalls for Culvert Pipe Reinforced Concrete 30-Inch	EACH
522.1036	Apron Endwalls for Culvert Pipe Reinforced Concrete 36-Inch	EACH
522.1042	Apron Endwalls for Culvert Pipe Reinforced Concrete 42-Inch	EACH
522.1048	Apron Endwalls for Culvert Pipe Reinforced Concrete 48-Inch	EACH
522.1054	Apron Endwalls for Culvert Pipe Reinforced Concrete 54-Inch	EACH
522.1060	Apron Endwalls for Culvert Pipe Reinforced Concrete 60-Inch	EACH
522.1066	Apron Endwalls for Culvert Pipe Reinforced Concrete 66-Inch	EACH
522.1072	Apron Endwalls for Culvert Pipe Reinforced Concrete 72-Inch	EACH
522.1084	Apron Endwalls for Culvert Pipe Reinforced Concrete 84-Inch	EACH
522.2000	Pipe Cattle Pass Reinforced Concrete	LF
523.0114	Culvert Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 14x23-Inch	LF
523.0119	Culvert Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 19x30-Inch	LF
523.0124	Culvert Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 24x38-Inch	LF
523.0129	Culvert Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 29x45-Inch	LF
523.0134	Culvert Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 34x53-Inch	LF
523.0138	Culvert Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 38x60-Inch	LF
523.0143	Culvert Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 43x68-Inch	LF
523.0148	Culvert Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 48x76-Inch	LF
523.0153	Culvert Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 53x83-Inch	LF
523.0158	Culvert Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 58x91-Inch	LF
523.0163	Culvert Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 63x98-Inch	LF
523.0168	Culvert Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 68x106-Inch	LF
523.0514	Apron Endwalls for Culvert Pipe Reinforced Concrete Horizontal Elliptical 14x23-Inch	EACH
523.0519	Apron Endwalls for Culvert Pipe Reinforced Concrete Horizontal Elliptical 19x30-Inch	EACH
523.0524	Apron Endwalls for Culvert Pipe Reinforced Concrete Horizontal Elliptical 24x38-Inch	EACH
523.0529	Apron Endwalls for Culvert Pipe Reinforced Concrete Horizontal Elliptical 29x45-Inch	EACH
523.0534	Apron Endwalls for Culvert Pipe Reinforced Concrete Horizontal Elliptical 34x53-Inch	EACH
523.0538	Apron Endwalls for Culvert Pipe Reinforced Concrete Horizontal Elliptical 38x60-Inch	EACH
523.0543	Apron Endwalls for Culvert Pipe Reinforced Concrete Horizontal Elliptical 43x68-Inch	EACH
523.0548	Apron Endwalls for Culvert Pipe Reinforced Concrete Horizontal Elliptical 48x76-Inch	EACH
523.0553	Apron Endwalls for Culvert Pipe Reinforced Concrete Horizontal Elliptical 53x83-Inch	EACH
523.0558	Apron Endwalls for Culvert Pipe Reinforced Concrete Horizontal Elliptical 58x91-Inch	EACH
523.0563	Apron Endwalls for Culvert Pipe Reinforced Concrete Horizontal Elliptical 63x98-Inch	EACH
523.0568	Apron Endwalls for Culvert Pipe Reinforced Concrete Horizontal Elliptical 68x106-Inch	EACH
524.0112	Culvert Pipe Salvaged 12-Inch	LF
524.0115	Culvert Pipe Salvaged 15-Inch	LF
524.0118	Culvert Pipe Salvaged 18-Inch	LF
524.0121	Culvert Pipe Salvaged 21-Inch	LF
524.0124	Culvert Pipe Salvaged 24-Inch	LF
524.0127	Culvert Pipe Salvaged 27-Inch	LF
524.0130	Culvert Pipe Salvaged 30-Inch	LF
524.0133	Culvert Pipe Salvaged 33-Inch	LF
524.0136	Culvert Pipe Salvaged 36-Inch	LF
524.0142	Culvert Pipe Salvaged 42-Inch	LF
524.0148	Culvert Pipe Salvaged 48-Inch	LF
524.0154	Culvert Pipe Salvaged 54-Inch	LF
524.0160	Culvert Pipe Salvaged 60-Inch	LF
524.0166	Culvert Pipe Salvaged 66-Inch	LF
524.0172	Culvert Pipe Salvaged 72-Inch	LF
524.0178	Culvert Pipe Salvaged 78-Inch	LF
524.0184	Culvert Pipe Salvaged 84-Inch	LF
524.0190	Culvert Pipe Salvaged 90-Inch	LF
524.0196	Culvert Pipe Salvaged 96-Inch	LF

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
524.0202	Culvert Pipe Salvaged 102-Inch	LF
524.0208	Culvert Pipe Salvaged 108-Inch	LF
524.0612	Apron Endwalls for Culvert Pipe Salvaged 12-Inch	EACH
524.0615	Apron Endwalls for Culvert Pipe Salvaged 15-Inch	EACH
524.0618	Apron Endwalls for Culvert Pipe Salvaged 18-Inch	EACH
524.0621	Apron Endwalls for Culvert Pipe Salvaged 21-Inch	EACH
524.0624	Apron Endwalls for Culvert Pipe Salvaged 24-Inch	EACH
524.0627	Apron Endwalls for Culvert Pipe Salvaged 27-Inch	EACH
524.0630	Apron Endwalls for Culvert Pipe Salvaged 30-Inch	EACH
524.0633	Apron Endwalls for Culvert Pipe Salvaged 33-Inch	EACH
524.0636	Apron Endwalls for Culvert Pipe Salvaged 36-Inch	EACH
524.0642	Apron Endwalls for Culvert Pipe Salvaged 42-Inch	EACH
524.0648	Apron Endwalls for Culvert Pipe Salvaged 48-Inch	EACH
524.0654	Apron Endwalls for Culvert Pipe Salvaged 54-Inch	EACH
524.0660	Apron Endwalls for Culvert Pipe Salvaged 60-Inch	EACH
524.0666	Apron Endwalls for Culvert Pipe Salvaged 66-Inch	EACH
524.0672	Apron Endwalls for Culvert Pipe Salvaged 72-Inch	EACH
524.0678	Apron Endwalls for Culvert Pipe Salvaged 78-Inch	EACH
524.0684	Apron Endwalls for Culvert Pipe Salvaged 84-Inch	EACH
524.0800	Pipe Cattle Pass Salvaged	LF
524.0900	Pipe Arch Salvaged Corrugated Steel (rise x span)	LF
525.0112	Culvert Pipe Corrugated Aluminum 12-Inch	LF
525.0115	Culvert Pipe Corrugated Aluminum 15-Inch	LF
525.0118	Culvert Pipe Corrugated Aluminum 18-Inch	LF
525.0121	Culvert Pipe Corrugated Aluminum 21-Inch	LF
525.0124	Culvert Pipe Corrugated Aluminum 24-Inch	LF
525.0130	Culvert Pipe Corrugated Aluminum 30-Inch	LF
525.0136	Culvert Pipe Corrugated Aluminum 36-Inch	LF
525.0142	Culvert Pipe Corrugated Aluminum 42-Inch	LF
525.0148	Culvert Pipe Corrugated Aluminum 48-Inch	LF
525.0154	Culvert Pipe Corrugated Aluminum 54-Inch	LF
525.0160	Culvert Pipe Corrugated Aluminum 60-Inch	LF
525.0172	Culvert Pipe Corrugated Aluminum 72-Inch	LF
525.0184	Culvert Pipe Corrugated Aluminum 84-Inch	LF
525.0512	Apron Endwalls for Culvert Pipe Aluminum 12-Inch	EACH
525.0515	Apron Endwalls for Culvert Pipe Aluminum 15-Inch	EACH
525.0518	Apron Endwalls for Culvert Pipe Aluminum 18-Inch	EACH
525.0521	Apron Endwalls for Culvert Pipe Aluminum 21-Inch	EACH
525.0524	Apron Endwalls for Culvert Pipe Aluminum 24-Inch	EACH
525.0530	Apron Endwalls for Culvert Pipe Aluminum 30-Inch	EACH
525.0536	Apron Endwalls for Culvert Pipe Aluminum 36-Inch	EACH
525.0542	Apron Endwalls for Culvert Pipe Aluminum 42-Inch	EACH
525.0548	Apron Endwalls for Culvert Pipe Aluminum 48-Inch	EACH
525.0554	Apron Endwalls for Culvert Pipe Aluminum 54-Inch	EACH
525.0560	Apron Endwalls for Culvert Pipe Aluminum 60-Inch	EACH
525.0572	Apron Endwalls for Culvert Pipe Aluminum 72-Inch	EACH
525.0584	Apron Endwalls for Culvert Pipe Aluminum 84-Inch	EACH
526.0100	Temporary Structure (station)	LS
527.0160	Pipe Structural Plate 60-Inch	LF
527.0172	Pipe Structural Plate 72-Inch	LF
527.0184	Pipe Structural Plate 84-Inch	LF
527.0196	Pipe Structural Plate 96-Inch	LF
527.0208	Pipe Structural Plate 108-Inch	LF
527.0220	Pipe Structural Plate 120-Inch	LF
527.0232	Pipe Structural Plate 132-Inch	LF
527.0244	Pipe Structural Plate 144-Inch	LF

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
527.0256	Pipe Structural Plate 156-Inch	LF
527.0268	Pipe Structural Plate 168-Inch	LF
527.0280	Pipe Structural Plate 180-Inch	LF
527.0305	Pipe Arch Structural Plate 6-FT Span	LF
527.0310	Pipe Arch Structural Plate 7-FT Span	LF
527.0315	Pipe Arch Structural Plate 8-FT Span	LF
527.0320	Pipe Arch Structural Plate 9-FT Span	LF
527.0325	Pipe Arch Structural Plate 10-FT Span	LF
527.0330	Pipe Arch Structural Plate 11-FT Span	LF
527.0335	Pipe Arch Structural Plate 12-FT Span	LF
527.0340	Pipe Arch Structural Plate 13-FT Span	LF
527.0345	Pipe Arch Structural Plate 14-FT Span	LF
527.0350	Pipe Arch Structural Plate 15-FT Span	LF
527.0355	Pipe Arch Structural Plate 16-FT Span	LF
527.0360	Pipe Arch Structural Plate 16.5-FT Span	LF
528.0112	Culvert Pipe Corrugated Steel Polymer Coated 12-Inch	LF
528.0115	Culvert Pipe Corrugated Steel Polymer Coated 15-Inch	LF
528.0118	Culvert Pipe Corrugated Steel Polymer Coated 18-Inch	LF
528.0121	Culvert Pipe Corrugated Steel Polymer Coated 21-Inch	LF
528.0124	Culvert Pipe Corrugated Steel Polymer Coated 24-Inch	LF
528.0130	Culvert Pipe Corrugated Steel Polymer Coated 30-Inch	LF
528.0136	Culvert Pipe Corrugated Steel Polymer Coated 36-Inch	LF
528.0142	Culvert Pipe Corrugated Steel Polymer Coated 42-Inch	LF
528.0148	Culvert Pipe Corrugated Steel Polymer Coated 48-Inch	LF
528.0154	Culvert Pipe Corrugated Steel Polymer Coated 54-Inch	LF
528.0160	Culvert Pipe Corrugated Steel Polymer Coated 60-Inch	LF
528.0172	Culvert Pipe Corrugated Steel Polymer Coated 72-Inch	LF
528.0184	Culvert Pipe Corrugated Steel Polymer Coated 84-Inch	LF
528.0196	Culvert Pipe Corrugated Steel Polymer Coated 96-Inch	LF
528.0317	Pipe Arch Polymer Coated Corrugated Steel 17x13-Inch	LF
528.0321	Pipe Arch Polymer Coated Corrugated Steel 21x15-Inch	LF
528.0324	Pipe Arch Polymer Coated Corrugated Steel 24x18-Inch	LF
528.0328	Pipe Arch Polymer Coated Corrugated Steel 28x20-Inch	LF
528.0335	Pipe Arch Polymer Coated Corrugated Steel 35x24-Inch	LF
528.0342	Pipe Arch Polymer Coated Corrugated Steel 42x29-Inch	LF
528.0349	Pipe Arch Polymer Coated Corrugated Steel 49x33-Inch	LF
528.0357	Pipe Arch Polymer Coated Corrugated Steel 57x38-Inch	LF
528.0364	Pipe Arch Polymer Coated Corrugated Steel 64x43-Inch	LF
528.0371	Pipe Arch Polymer Coated Corrugated Steel 71x47-Inch	LF
528.0377	Pipe Arch Polymer Coated Corrugated Steel 77x52-Inch	LF
528.0383	Pipe Arch Polymer Coated Corrugated Steel 83x57-Inch	LF
529.0112	Culvert Pipe Corrugated Steel Aluminum Coated 12-Inch	LF
529.0115	Culvert Pipe Corrugated Steel Aluminum Coated 15-Inch	LF
529.0118	Culvert Pipe Corrugated Steel Aluminum Coated 18-Inch	LF
529.0121	Culvert Pipe Corrugated Steel Aluminum Coated 21-Inch	LF
529.0124	Culvert Pipe Corrugated Steel Aluminum Coated 24-Inch	LF
529.0130	Culvert Pipe Corrugated Steel Aluminum Coated 30-Inch	LF
529.0136	Culvert Pipe Corrugated Steel Aluminum Coated 36-Inch	LF
529.0142	Culvert Pipe Corrugated Steel Aluminum Coated 42-Inch	LF
529.0148	Culvert Pipe Corrugated Steel Aluminum Coated 48-Inch	LF
529.0154	Culvert Pipe Corrugated Steel Aluminum Coated 54-Inch	LF
529.0160	Culvert Pipe Corrugated Steel Aluminum Coated 60-Inch	LF
529.0172	Culvert Pipe Corrugated Steel Aluminum Coated 72-Inch	LF
529.0184	Culvert Pipe Corrugated Steel Aluminum Coated 84-Inch	LF
529.0196	Culvert Pipe Corrugated Steel Aluminum Coated 96-Inch	LF
529.0317	Pipe Arch Corrugated Steel Aluminum Coated 17x13-Inch	LF

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
529.0321	Pipe Arch Corrugated Steel Aluminum Coated 21x15-Inch	LF
529.0324	Pipe Arch Corrugated Steel Aluminum Coated 24x18-Inch	LF
529.0328	Pipe Arch Corrugated Steel Aluminum Coated 28x20-Inch	LF
529.0335	Pipe Arch Corrugated Steel Aluminum Coated 35x24-Inch	LF
529.0342	Pipe Arch Corrugated Steel Aluminum Coated 42x29-Inch	LF
529.0349	Pipe Arch Corrugated Steel Aluminum Coated 49x33-Inch	LF
529.0357	Pipe Arch Corrugated Steel Aluminum Coated 57x38-Inch	LF
529.0364	Pipe Arch Corrugated Steel Aluminum Coated 64x43-Inch	LF
529.0371	Pipe Arch Corrugated Steel Aluminum Coated 71x47-Inch	LF
529.0377	Pipe Arch Corrugated Steel Aluminum Coated 77x52-Inch	LF
529.0383	Pipe Arch Corrugated Steel Aluminum Coated 83x57-Inch	LF
530.0112	Culvert Pipe Corrugated Polyethylene 12-Inch	LF
530.0115	Culvert Pipe Corrugated Polyethylene 15-Inch	LF
530.0118	Culvert Pipe Corrugated Polyethylene 18-Inch	LF
530.0124	Culvert Pipe Corrugated Polyethylene 24-Inch	LF
530.0130	Culvert Pipe Corrugated Polyethylene 30-Inch	LF
530.0136	Culvert Pipe Corrugated Polyethylene 36-Inch	LF
601.0105	Concrete Curb Type A	LF
601.0110	Concrete Curb Type D	LF
601.0115	Concrete Curb Type G	LF
601.0120	Concrete Curb Type J	LF
601.0150	Concrete Curb Integral Type D	LF
601.0155	Concrete Curb Integral Type J	LF
601.0205	Concrete Gutter 24-Inch	LF
601.0318	Concrete Curb & Gutter 18-Inch	LF
601.0322	Concrete Curb & Gutter 22-Inch	LF
601.0331	Concrete Curb & Gutter 31-Inch	LF
601.0342	Concrete Curb & Gutter Integral 18-Inch	LF
601.0344	Concrete Curb & Gutter Integral 36-Inch	LF
601.0405	Concrete Curb & Gutter 18-Inch Type A	LF
601.0407	Concrete Curb & Gutter 18-Inch Type D	LF
601.0409	Concrete Curb & Gutter 30-Inch Type A	LF
601.0411	Concrete Curb & Gutter 30-Inch Type D	LF
601.0413	Concrete Curb & Gutter 30-Inch Type G	LF
601.0415	Concrete Curb & Gutter 30-Inch Type J	LF
601.0417	Concrete Curb & Gutter 30-Inch Type K	LF
601.0419	Concrete Curb & Gutter 30-Inch Type L	LF
601.0421	Concrete Curb & Gutter 36-Inch Type A	LF
601.0423	Concrete Curb & Gutter 36-Inch Type D	LF
601.0452	Concrete Curb & Gutter Integral 30-Inch Type D	LF
601.0454	Concrete Curb & Gutter Integral 30-Inch Type J	LF
601.0456	Concrete Curb & Gutter Integral 30-Inch Type L	LF
601.0502	Concrete Curb & Gutter Integral 4-Inch Mountable 36-Inch	LF
601.0512	Concrete Curb & Gutter Integral 6-Inch Mountable 36-Inch	LF
601.0552	Concrete Curb & Gutter 4-Inch Mountable 36-Inch Type A	LF
601.0554	Concrete Curb & Gutter 4-Inch Mountable 36-Inch Type D	LF
601.0556	Concrete Curb & Gutter 6-Inch Mountable 36-Inch Type A	LF
601.0558	Concrete Curb & Gutter 6-Inch Mountable 36-Inch Type D	LF
602.0405	Concrete Sidewalk 4-Inch	SF
602.0410	Concrete Sidewalk 5-Inch	SF
602.0415	Concrete Sidewalk 6-Inch	SF
602.0420	Concrete Sidewalk 7-Inch	SF
602.1000	Concrete Loading Zone	SF
602.1500	Concrete Steps	SF
602.2400	Concrete Safety Islands	SF
603.0105	Concrete Barrier Single-Faced 32-Inch	LF

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
603.0110	Concrete Barrier Single-Faced 42-Inch	LF
603.0115	Concrete Barrier Single-Faced 51-Inch	LF
603.0205	Concrete Barrier Double-Faced 32-Inch	LF
603.0210	Concrete Barrier Double-Faced 42-Inch	LF
603.0215	Concrete Barrier Double-Faced 51-Inch	LF
603.0405	Concrete Barrier Transition Section 32-Inch	LF
603.0410	Concrete Barrier Transition Section 42-Inch	LF
603.0415	Concrete Barrier Transition Section 51-Inch	LF
603.0500	Concrete Barrier Temporary Precast Contractor Furnished & Delivered	LF
603.0600	Concrete Barrier Temporary Precast State Owned Contractor Delivered	LF
603.0800	Concrete Barrier Temporary Precast Contractor Furnished & Installed	LF
603.0900	Concrete Barrier Temporary Precast State Owned Contractor Installed	LF
604.0400	Slope Paving Concrete	SY
604.0500	Slope Paving Crushed Aggregate	SY
605.0305	Ditch Checks Mortar Rubble	CY
605.0405	Ditch Checks Concrete	CY
606.0100	Riprap Light	CY
606.0200	Riprap Medium	CY
606.0300	Riprap Heavy	CY
606.0400	Riprap Extra-Heavy	CY
606.0500	Grouted Riprap Light	CY
606.0600	Grouted Riprap Medium	CY
606.0700	Grouted Riprap Heavy	CY
606.0800	Grouted Riprap Extra-Heavy	CY
607.0106	Storm Sewer Pipe Nonreinforced Concrete Class 1 6-Inch	LF
607.0108	Storm Sewer Pipe Nonreinforced Concrete Class 1 8-Inch	LF
607.0110	Storm Sewer Pipe Nonreinforced Concrete Class 1 10-Inch	LF
607.0112	Storm Sewer Pipe Nonreinforced Concrete Class 1 12-Inch	LF
607.0115	Storm Sewer Pipe Nonreinforced Concrete Class 1 15-Inch	LF
607.0118	Storm Sewer Pipe Nonreinforced Concrete Class 1 18-Inch	LF
607.0121	Storm Sewer Pipe Nonreinforced Concrete Class 1 21-Inch	LF
607.0124	Storm Sewer Pipe Nonreinforced Concrete Class 1 24-Inch	LF
607.0130	Storm Sewer Pipe Nonreinforced Concrete Class 1 30-Inch	LF
607.0136	Storm Sewer Pipe Nonreinforced Concrete Class 1 36-Inch	LF
607.0306	Storm Sewer Pipe Nonreinforced Concrete Class 3 6-Inch	LF
607.0308	Storm Sewer Pipe Nonreinforced Concrete Class 3 8-Inch	LF
607.0310	Storm Sewer Pipe Nonreinforced Concrete Class 3 10-Inch	LF
607.0312	Storm Sewer Pipe Nonreinforced Concrete Class 3 12-Inch	LF
607.0315	Storm Sewer Pipe Nonreinforced Concrete Class 3 15-Inch	LF
607.0318	Storm Sewer Pipe Nonreinforced Concrete Class 3 18-Inch	LF
607.0321	Storm Sewer Pipe Nonreinforced Concrete Class 3 21-Inch	LF
607.0324	Storm Sewer Pipe Nonreinforced Concrete Class 3 24-Inch	LF
607.0330	Storm Sewer Pipe Nonreinforced Concrete Class 3 30-Inch	LF
607.0336	Storm Sewer Pipe Nonreinforced Concrete Class 3 36-Inch	LF
607.0406	Storm Sewer Pipe Composite 6-Inch	LF
607.0408	Storm Sewer Pipe Composite 8-Inch	LF
607.0410	Storm Sewer Pipe Composite 1-Inch	LF
607.0412	Storm Sewer Pipe Composite 12-Inch	LF
607.0415	Storm Sewer Pipe Composite 15-Inch	LF
607.5000	Storm Sewer Rock Excavation	CY
608.0212	Storm Sewer Pipe Reinforced Concrete Class II 12-Inch	LF
608.0215	Storm Sewer Pipe Reinforced Concrete Class II 15-Inch	LF
608.0218	Storm Sewer Pipe Reinforced Concrete Class II 18-Inch	LF
608.0221	Storm Sewer Pipe Reinforced Concrete Class II 21-Inch	LF
608.0224	Storm Sewer Pipe Reinforced Concrete Class II 24-Inch	LF
608.0227	Storm Sewer Pipe Reinforced Concrete Class II 27-Inch	LF

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
608.0230	Storm Sewer Pipe Reinforced Concrete Class II 30-Inch	LF
608.0236	Storm Sewer Pipe Reinforced Concrete Class II 36-Inch	LF
608.0242	Storm Sewer Pipe Reinforced Concrete Class II 42-Inch	LF
608.0248	Storm Sewer Pipe Reinforced Concrete Class II 48-Inch	LF
608.0254	Storm Sewer Pipe Reinforced Concrete Class II 54-Inch	LF
608.0260	Storm Sewer Pipe Reinforced Concrete Class II 60-Inch	LF
608.0266	Storm Sewer Pipe Reinforced Concrete Class II 66-Inch	LF
608.0272	Storm Sewer Pipe Reinforced Concrete Class II 72-Inch	LF
608.0278	Storm Sewer Pipe Reinforced Concrete Class II 78-Inch	LF
608.0284	Storm Sewer Pipe Reinforced Concrete Class II 84-Inch	LF
608.0290	Storm Sewer Pipe Reinforced Concrete Class II 90-Inch	LF
608.0296	Storm Sewer Pipe Reinforced Concrete Class II 96-Inch	LF
608.0297	Storm Sewer Pipe Reinforced Concrete Class II 102-Inch	LF
608.0298	Storm Sewer Pipe Reinforced Concrete Class II 108-Inch	LF
608.0312	Storm Sewer Pipe Reinforced Concrete Class III 12-Inch	LF
608.0315	Storm Sewer Pipe Reinforced Concrete Class III 15-Inch	LF
608.0318	Storm Sewer Pipe Reinforced Concrete Class III 18-Inch	LF
608.0321	Storm Sewer Pipe Reinforced Concrete Class III 21-Inch	LF
608.0324	Storm Sewer Pipe Reinforced Concrete Class III 24-Inch	LF
608.0327	Storm Sewer Pipe Reinforced Concrete Class III 27-Inch	LF
608.0330	Storm Sewer Pipe Reinforced Concrete Class III 30-Inch	LF
608.0336	Storm Sewer Pipe Reinforced Concrete Class III 36-Inch	LF
608.0342	Storm Sewer Pipe Reinforced Concrete Class III 42-Inch	LF
608.0348	Storm Sewer Pipe Reinforced Concrete Class III 48-Inch	LF
608.0354	Storm Sewer Pipe Reinforced Concrete Class III 54-Inch	LF
608.0360	Storm Sewer Pipe Reinforced Concrete Class III 60-Inch	LF
608.0366	Storm Sewer Pipe Reinforced Concrete Class III 66-Inch	LF
608.0372	Storm Sewer Pipe Reinforced Concrete Class III 72-Inch	LF
608.0378	Storm Sewer Pipe Reinforced Concrete Class III 78-Inch	LF
608.0384	Storm Sewer Pipe Reinforced Concrete Class III 84-Inch	LF
608.0390	Storm Sewer Pipe Reinforced Concrete Class III 90-Inch	LF
608.0396	Storm Sewer Pipe Reinforced Concrete Class III 96-Inch	LF
608.0397	Storm Sewer Pipe Reinforced Concrete Class III 102-Inch	LF
608.0398	Storm Sewer Pipe Reinforced Concrete Class III 108-Inch	LF
608.0412	Storm Sewer Pipe Reinforced Concrete Class IV 12-Inch	LF
608.0415	Storm Sewer Pipe Reinforced Concrete Class IV 15-Inch	LF
608.0418	Storm Sewer Pipe Reinforced Concrete Class IV 18-Inch	LF
608.0421	Storm Sewer Pipe Reinforced Concrete Class IV 21-Inch	LF
608.0424	Storm Sewer Pipe Reinforced Concrete Class IV 24-Inch	LF
608.0427	Storm Sewer Pipe Reinforced Concrete Class IV 27-Inch	LF
608.0430	Storm Sewer Pipe Reinforced Concrete Class IV 30-Inch	LF
608.0436	Storm Sewer Pipe Reinforced Concrete Class IV 36-Inch	LF
608.0442	Storm Sewer Pipe Reinforced Concrete Class IV 42-Inch	LF
608.0448	Storm Sewer Pipe Reinforced Concrete Class IV 48-Inch	LF
608.0454	Storm Sewer Pipe Reinforced Concrete Class IV 54-Inch	LF
608.0460	Storm Sewer Pipe Reinforced Concrete Class IV 60-Inch	LF
608.0466	Storm Sewer Pipe Reinforced Concrete Class IV 66-Inch	LF
608.0472	Storm Sewer Pipe Reinforced Concrete Class IV 72-Inch	LF
608.0478	Storm Sewer Pipe Reinforced Concrete Class IV 78-Inch	LF
608.0484	Storm Sewer Pipe Reinforced Concrete Class IV 84-Inch	LF
608.0512	Storm Sewer Pipe Reinforced Concrete Class V 12-Inch	LF
608.0515	Storm Sewer Pipe Reinforced Concrete Class V 15-Inch	LF
608.0518	Storm Sewer Pipe Reinforced Concrete Class V 18-Inch	LF
608.0521	Storm Sewer Pipe Reinforced Concrete Class V 21-Inch	LF
608.0524	Storm Sewer Pipe Reinforced Concrete Class V 24-Inch	LF
608.0527	Storm Sewer Pipe Reinforced Concrete Class V 27-Inch	LF

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
608.0530	Storm Sewer Pipe Reinforced Concrete Class V 30-Inch	LF
608.0536	Storm Sewer Pipe Reinforced Concrete Class V 36-Inch	LF
608.0542	Storm Sewer Pipe Reinforced Concrete Class V 42-Inch	LF
608.0548	Storm Sewer Pipe Reinforced Concrete Class V 48-Inch	LF
608.0554	Storm Sewer Pipe Reinforced Concrete Class V 54-Inch	LF
608.0560	Storm Sewer Pipe Reinforced Concrete Class V 60-Inch	LF
608.0566	Storm Sewer Pipe Reinforced Concrete Class V 66-Inch	LF
608.0572	Storm Sewer Pipe Reinforced Concrete Class V 72-Inch	LF
609.0106	Relaid Storm Sewer 6-Inch	LF
609.0108	Relaid Storm Sewer 8-Inch	LF
609.0110	Relaid Storm Sewer 10-Inch	LF
609.0112	Relaid Storm Sewer 12-Inch	LF
609.0115	Relaid Storm Sewer 15-Inch	LF
609.0118	Relaid Storm Sewer 18-Inch	LF
609.0121	Relaid Storm Sewer 21-Inch	LF
609.0124	Relaid Storm Sewer 24-Inch	LF
609.0127	Relaid Storm Sewer 27-Inch	LF
609.0130	Relaid Storm Sewer 30-Inch	LF
609.0136	Relaid Storm Sewer 36-Inch	LF
609.0142	Relaid Storm Sewer 42-Inch	LF
609.0148	Relaid Storm Sewer 48-Inch	LF
609.0154	Relaid Storm Sewer 54-Inch	LF
609.0160	Relaid Storm Sewer 60-Inch	LF
609.0166	Relaid Storm Sewer 66-Inch	LF
609.0172	Relaid Storm Sewer 72-Inch	LF
609.0178	Relaid Storm Sewer 78-Inch	LF
609.0184	Relaid Storm Sewer 84-Inch	LF
609.0190	Relaid Storm Sewer 90-Inch	LF
609.0196	Relaid Storm Sewer 96-Inch	LF
610.0114	Storm Sewer Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 14x23-Inch	LF
610.0119	Storm Sewer Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 19x30-Inch	LF
610.0124	Storm Sewer Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 24x38-Inch	LF
610.0129	Storm Sewer Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 29x45-Inch	LF
610.0134	Storm Sewer Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 34x53-Inch	LF
610.0138	Storm Sewer Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 38x60-Inch	LF
610.0143	Storm Sewer Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 43x68-Inch	LF
610.0148	Storm Sewer Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 48x76-Inch	LF
610.0153	Storm Sewer Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 53x83-Inch	LF
610.0158	Storm Sewer Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 58x91-Inch	LF
610.0163	Storm Sewer Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 63x98-Inch	LF
610.0168	Storm Sewer Pipe Reinforced Concrete Horizontal Elliptical Class HE-III 68x106-Inch	LF
611.0101	Catch Basins Type 1	EACH
611.0103	Catch Basins Type 2	EACH
611.0105	Catch Basins Type 3	EACH
611.0107	Catch Basins Type 5	EACH
611.0141	Catch Basins Type 41	EACH
611.0145	Catch Basins Type 42	EACH
611.0147	Catch Basins Type 43	EACH
611.0201	Manholes Type 1	EACH
611.0202	Manholes Type 1-Communications	EACH
611.0205	Manholes Type 2	EACH
611.0210	Manholes Type 3	EACH
611.0215	Manholes Type 5	EACH
611.0220	Manholes Type 6	EACH
611.0225	Manholes Type 11	EACH
611.0230	Manholes Type 12	EACH

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
611.0235	Manholes Type 13	EACH
611.0240	Manholes Type 14	EACH
611.0301	Inlets Type 1	EACH
611.0302	Inlets Type 2	EACH
611.0303	Inlets Type 3	EACH
611.0304	Inlets Type 4	EACH
611.0305	Inlets Type 8	EACH
611.0307	Inlets Type 9	EACH
611.0309	Inlets Type 10	EACH
611.0311	Inlets Type 11	EACH
611.0330	Inlets Type 30	EACH
611.0331	Inlets Type 31	EACH
611.0333	Inlets Type 32	EACH
611.0335	Inlets Type 34	EACH
611.0337	Inlets Type 35	EACH
611.0339	Inlets Type 37	EACH
611.0341	Inlets Type 38	EACH
611.0342	Inlets Type 38A	EACH
611.0343	Inlets Type 39	EACH
611.0344	Inlets Type 39A	EACH
611.0347	Inlets Type 40	EACH
611.0410	Reconstructing Catch Basins	EACH
611.0420	Reconstructing Manholes	EACH
611.0430	Reconstructing Inlets	EACH
611.0530	Manhole Covers Type J	EACH
611.0535	Manhole Covers Type J-Special	EACH
611.0540	Manhole Covers Type K	EACH
611.0545	Manhole Covers Type L	EACH
611.0550	Manhole Covers Type M	EACH
611.0552	Manhole Covers Type M-Communications	EACH
611.0555	Manhole Covers Type Q	EACH
611.0557	Manhole Covers Type Q-Communications	EACH
611.0600	Inlet Covers Type A	EACH
611.0603	Inlet Covers Type A-S	EACH
611.0606	Inlet Covers Type B	EACH
611.0609	Inlet Covers Type B-A	EACH
611.0612	Inlet Covers Type C	EACH
611.0615	Inlet Covers Type F	EACH
611.0618	Inlet Covers Type GM	EACH
611.0621	Inlet Covers Type GM-A	EACH
611.0624	Inlet Covers Type H	EACH
611.0627	Inlet Covers Type HM	EACH
611.0630	Inlet Covers Type HM-GJ	EACH
611.0633	Inlet Covers Type HM-GJ-S	EACH
611.0636	Inlet Covers Type HM-S	EACH
611.0639	Inlet Covers Type H-S	EACH
611.0642	Inlet Covers Type MS	EACH
611.0645	Inlet Covers Type MS-A	EACH
611.0648	Inlet Covers Type R	EACH
611.0651	Inlet Covers Type S	EACH
611.0654	Inlet Covers Type V	EACH
611.0657	Inlet Covers Type W	EACH
611.0660	Inlet Covers Type WM	EACH
611.0663	Inlet Covers Type X	EACH
611.0666	Inlet Covers Type Z	EACH
611.8105	Adjusting Catch Basin Covers	EACH

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
611.8110	Adjusting Manhole Covers	EACH
611.8115	Adjusting Inlet Covers	EACH
611.9705	Salvaged Manhole Covers	EACH
611.9710	Salvaged Inlet Covers	EACH
612.0104	Pipe Underdrain 4-Inch	LF
612.0106	Pipe Underdrain 6-Inch	LF
612.0108	Pipe Underdrain 8-Inch	LF
612.0110	Pipe Underdrain 10-Inch	LF
612.0112	Pipe Underdrain 12-Inch	LF
612.0115	Pipe Underdrain 15-Inch	LF
612.0118	Pipe Underdrain 18-Inch	LF
612.0121	Pipe Underdrain 21-Inch	LF
612.0204	Pipe Underdrain Unperforated 4-Inch	LF
612.0206	Pipe Underdrain Unperforated 6-Inch	LF
612.0208	Pipe Underdrain Unperforated 8-Inch	LF
612.0210	Pipe Underdrain Unperforated 10-Inch	LF
612.0212	Pipe Underdrain Unperforated 12-Inch	LF
612.0215	Pipe Underdrain Unperforated 15-Inch	LF
612.0218	Pipe Underdrain Unperforated 18-Inch	LF
612.0221	Pipe Underdrain Unperforated 21-Inch	LF
612.0304	Pipe Underdrain Drain Tile 4-Inch	LF
612.0305	Pipe Underdrain Drain Tile 5-Inch	LF
612.0306	Pipe Underdrain Drain Tile 6-Inch	LF
612.0308	Pipe Underdrain Drain Tile 8-Inch	LF
612.0310	Pipe Underdrain Drain Tile 10-Inch	LF
612.0312	Pipe Underdrain Drain Tile 12-Inch	LF
612.0314	Pipe Underdrain Drain Tile 14-Inch	LF
612.0315	Pipe Underdrain Drain Tile 15-Inch	LF
612.0316	Pipe Underdrain Drain Tile 16-Inch	LF
612.0318	Pipe Underdrain Drain Tile 18-Inch	LF
612.0322	Pipe Underdrain Drain Tile 22-Inch	LF
612.0324	Pipe Underdrain Drain Tile 24-Inch	LF
612.0330	Pipe Underdrain Drain Tile 30-Inch	LF
612.0404	Pipe Underdrain Wrapped 4-Inch	LF
612.0406	Pipe Underdrain Wrapped 6-Inch	LF
612.0408	Pipe Underdrain Wrapped 8-Inch	LF
612.0410	Pipe Underdrain Wrapped 10-Inch	LF
612.0412	Pipe Underdrain Wrapped 12-Inch	LF
612.0415	Pipe Underdrain Wrapped 15-Inch	LF
612.0504	Pipe Underdrain Wrapped and Plowed 4-Inch	LF
612.0506	Pipe Underdrain Wrapped and Plowed 6-Inch	LF
612.0600	Underdrain Trench	LF
612.0700	Drain Tile Exploration	LF
612.0804	Apron Endwalls for Underdrain Reinforced Concrete 4-Inch	EACH
612.0806	Apron Endwalls for Underdrain Reinforced Concrete 6-Inch	EACH
614.0100	Cable Guard Fence	LF
614.0103	Anchorage for Cable Guard Fence	EACH
614.0105	Anchorage for Steel Plate Beam Guard	EACH
614.0110	Anchorage for Steel Plate Beam Guard Temporary	EACH
614.0115	Anchorage for Steel Plate Beam Guard Type 2	EACH
614.0150	Anchor Assemblies for Steel Plate Beam Guard	EACH
614.0200	Steel Thrie Beam Structure Approach	LF
614.0250	Steel Thrie Beam Structure Approach Temporary	LF
614.0305	Steel Plate Beam Guard Class A	LF
614.0310	Steel Plate Beam Guard Class B	LF
614.0340	Steel Plate Beam Guard Over Low-Fill Culverts Class A	LF

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
614.0355	Steel Plate Beam Median Guard	LF
614.0360	Steel Plate Beam Guard Temporary	LF
614.0370	Steel Plate Beam Guard Energy Absorbing Terminal	EACH
614.0380	Steel Plate Beam guard Energy Absorbing Terminal Temporary	EACH
614.0400	Adjusting Steel Plate Beam Guard	LF
614.0500	Salvaged Guard Fence Cable	LF
614.0555	Salvaged Guard Fence Steel Beam	LF
614.0600	Marker Posts	EACH
614.0605	Marker Posts Right-of-Way	EACH
614.0700	Sand Barrels	EACH
614.0800	Crash Cushions Permanent	EACH
614.0805	Crash Cushions Permanent Low Maintenance	EACH
614.0905	Crash Cushions Temporary	EACH
615.0100	Guard Fence Timber Rail	LF
615.0200	Curbs Treated Timber	EACH
615.0300	Guard Posts Timber	EACH
615.0400	Marker Posts Rustic	EACH
615.1000	Wisconsin Historical Marker (project)	LS
616.0100	Fence Woven Wire (height)	LF
616.0204	Fence Chain Link 4-FT	LF
616.0205	Fence Chain Link 5-FT	LF
616.0206	Fence Chain Link 6-FT	LF
616.0207	Fence Chain Link 7-FT	LF
616.0208	Fence Chain Link 8-FT	LF
616.0329	Gates Chain Link (width)	EACH
616.0404	Fence Chain Link Salvaged 4-FT	LF
616.0405	Fence Chain Link Salvaged 5-FT	LF
616.0406	Fence Chain Link Salvaged 6-FT	LF
616.0407	Fence Chain Link Salvaged 7-FT	LF
616.0408	Fence Chain Link Salvaged 8-FT	LF
616.0500	Fence High Tensile Wire (height)	LF
617.0100	Hauling (material)	CYMI
618.0100	Maintenance and Repair of Haul Roads (project)	EACH
619.1000	Mobilization	EACH
620.0100	Concrete Corrugated Median	SF
620.0200	Concrete Median Blunt Nose	SF
620.0300	Concrete Median Sloped Nose	SF
621.0100	Landmark Reference Monuments	EACH
621.1100	Landmark Reference Monuments and Cast Iron Covers	EACH
621.1200	Landmark Reference Monuments and Aluminum Covers	EACH
623.0200	Dust Control Surface Treatment	SY
624.0100	Water	MGAL
625.0100	Topsoil	SY
625.0105	Topsoil	CY
625.0500	Salvaged Topsoil	SY
626.0200	Peat Humus	SY
627.0200	Mulching	SY
627.0205	Mulching	TON
628.1105	Erosion Bales Delivered	EACH
628.1110	Erosion Bales Installed	EACH
628.1505	Silt Fence Delivered	LF
628.1510	Silt Fence Installed	LF
628.1520	Silt Fence Maintenance	LF
628.1550	Silt Screen	LF
628.1905	Mobilizations Erosion Control	EACH
628.1910	Mobilizations Emergency Erosion Control	EACH

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
628.1920	Cleaning Sediment Basins	CY
628.2005	Erosion Mat Delivered Class I Type A	SY
628.2010	Erosion Mat Delivered Class I Type B	SY
628.2015	Erosion Mat Delivered Urban Class I Type A	SY
628.2020	Erosion Mat Delivered Urban Class I Type B	SY
628.2025	Erosion Mat Delivered Class II Type A	SY
628.2030	Erosion Mat Delivered Class II Type B	SY
628.2035	Erosion Mat Delivered Class II Type C	SY
628.2040	Erosion Mat Delivered Class III Type A	SY
628.2045	Erosion Mat Delivered Class III Type B	SY
628.2050	Erosion Mat Delivered Class III Type C	SY
628.2055	Erosion Mat Delivered Class III Type D	SY
628.3005	Erosion Mat Installed Class I Type A	SY
628.3010	Erosion Mat Installed Class I Type B	SY
628.3015	Erosion Mat Installed Urban Class I Type A	SY
628.3020	Erosion Mat Installed Urban Class I Type B	SY
628.3025	Erosion Mat Installed Class II Type A	SY
628.3030	Erosion Mat Installed Class II Type B	SY
628.3035	Erosion Mat Installed Class II Type C	SY
628.3040	Erosion Mat Installed Class III Type A	SY
628.3045	Erosion Mat Installed Class III Type B	SY
628.3050	Erosion Mat Installed Class III Type C	SY
628.3055	Erosion Mat Installed Class III Type D	SY
628.5505	Polyethylene Sheeting	SY
628.6005	Turbidity Barriers	SY
628.6505	Soil Stabilizer Type A	ACRE
628.6510	Soil Stabilizer Type B	ACRE
628.7005	Inlet Protection Type A	EACH
628.7010	Inlet Protection Type B	EACH
628.7015	Inlet Protection Type C	EACH
628.7020	Inlet Protection Type D	EACH
628.7505	Temporary Ditch Checks Delivered	LF
628.7510	Temporary Ditch Checks Installed	LF
628.7550	Culvert Pipe Ditch Checks	EACH
629.0205	Fertilizer Type A	CWT
629.0210	Fertilizer Type B	CWT
629.1100	Agricultural Limestone Treatment	TON
630.0110	Seeding Mixture No. 10	LB
630.0120	Seeding Mixture No. 20	LB
630.0130	Seeding Mixture No. 30	LB
630.0140	Seeding Mixture No. 40	LB
630.0160	Seeding Mixture No. 60	LB
630.0170	Seeding Mixture No. 70	LB
630.0171	Seeding Mixture No. 70A	LB
630.0200	Seeding Temporary	LB
630.0300	Seeding Borrow Pit	LB
630.0400	Seeding Nurse Crop	LB
631.0300	Sod Water	MGAL
631.1000	Sod Lawn	SY
631.1100	Sod Erosion Control	SY
631.1200	Sod Erosion Control Sandy Soil	SY
632.0100	Trees (species and size)	EACH
632.0200	Shrubs (species and size)	EACH
632.0300	Vines (species and size)	EACH
632.9100	Landscape Planting Surveillance and Care (cycle)	EACH
633.0100	Delineator Posts Steel	EACH

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
633.0200	Delineator Posts Flexible	EACH
633.0500	Delineators	EACH
633.1000	Delineator Brackets	EACH
633.1100	Delineators Temporary	EACH
634.0410	Posts Wood 4x4-Inch x 10-FT	EACH
634.0412	Posts Wood 4x4-Inch x 12-FT	EACH
634.0414	Posts Wood 4x4-Inch x 14-FT	EACH
634.0416	Posts Wood 4x4-Inch x 16-FT	EACH
634.0418	Posts Wood 4x4-Inch x 18-FT	EACH
634.0612	Posts Wood 4x6-Inch x 12-FT	EACH
634.0614	Posts Wood 4x6-Inch x 14-FT	EACH
634.0616	Posts Wood 4x6-Inch x 16-FT	EACH
634.0618	Posts Wood 4x6-Inch x 18-FT	EACH
634.0620	Posts Wood 4x6-Inch x 20-FT	EACH
634.0622	Posts Wood 4x6-Inch x 22-FT	EACH
634.0801	Posts Tubular Steel 2x2-Inch x 1.5-FT	EACH
634.0803	Posts Tubular Steel 2x2-Inch x 3-FT	EACH
634.0805	Posts Tubular Steel 2x2-Inch x 5-FT	EACH
634.0808	Posts Tubular Steel 2x2-Inch x 8-FT	EACH
634.0809	Posts Tubular Steel 2x2-Inch x 9.5-FT	EACH
634.0810	Posts Tubular Steel 2x2-Inch x 10-FT	EACH
634.0811	Posts Tubular Steel 2x2-Inch x 11-FT	EACH
634.0812	Posts Tubular Steel 2x2-Inch x 12-FT	EACH
634.0814	Posts Tubular Steel 2x2-Inch x 14-FT	EACH
634.0816	Posts Tubular Steel 2x2-Inch x 16-FT	EACH
635.0200	Sign Supports Structural Steel HS	LB
636.0100	Sign Supports Concrete Masonry	CY
636.0500	Sign Supports Steel Reinforcement	LB
636.1000	Sign Supports Steel Reinforcement HS	LB
636.1500	Sign Supports Steel Coated Reinforcement HS	LB
637.0101	Signs Type I	SF
637.0103	Signs Type III	SF
637.0202	Signs Reflective Type II	SF
637.0302	Signs Non Reflective Type II	SF
638.2101	Moving Signs Type I	EACH
638.2102	Moving Signs Type II	EACH
638.2103	Moving Signs Type III	EACH
638.2601	Removing Signs Type I	EACH
638.2602	Removing Signs Type II	EACH
638.2603	Removing Signs Type III	EACH
638.3000	Removing Small Sign Supports	EACH
638.3100	Removing Structural Steel Sign Supports	EACH
638.3210	Revising Signs Type I	EACH
638.3230	Revising Signs Type III	EACH
638.3610	Erecting State Owned Signs Type I	EACH
638.3620	Erecting State Owned Signs Type II	EACH
638.3630	Erecting State Owned Signs Type III	EACH
638.4000	Moving Small Sign Supports	EACH
638.4100	Moving Structural Steel Sign Supports	EACH
639.0106	Drill Hole in Earth 6-Inch	LF
639.0108	Drill Hole in Earth 8-Inch	LF
639.0110	Drill Hole in Earth 10-Inch	LF
639.0112	Drill Hole in Earth 12-Inch	LF
639.0504	Drill Hole in Rock 4-Inch	LF
639.0506	Drill Hole in Rock 6-Inch	LF
639.0508	Drill Hole in Rock 8-Inch	LF

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
639.0510	Drill Hole in Rock 10-Inch	LF
639.0512	Drill Hole in Rock 12-Inch	LF
639.1004	Well Casing Pipe 4-Inch	LF
639.1006	Well Casing Pipe 6-Inch	LF
639.1008	Well Casing Pipe 8-Inch	LF
639.1010	Well Casing Pipe 10-Inch	LF
639.1012	Well Casing Pipe 12-Inch	LF
639.1700	Well Screen	LF
639.2100	Grout for Sealing Well Casing	CF
639.2500	Pump and Well Platform	EACH
639.3000	Wayside Well Shelter	EACH
639.4000	Test Pumping	EACH
641.0100	Sign Bridge Single Pole Sign Support One Sign (structure)	LS
641.0600	Sign Bridge Single Pole Sign Support Two Signs (structure)	LS
641.1200	Sign Bridge Cantilevered (structure)	LS
641.5100	Sign Bridge Structure Mounted (structure)	LS
641.6600	Sign Bridge (structure)	LS
641.8100	Overhead Sign Support (structure)	LS
642.5000	Field Office Type B (project)	EACH
642.5200	Field Office Type C (project)	EACH
642.5400	Field Office Type D (project)	EACH
642.6000	Field Laboratory (project)	EACH
643.0100	Traffic Control (project)	EACH
643.0200	Traffic Control Surveillance and Maintenance (project)	DAYS
643.0300	Traffic Control Drums	DAYS
643.0405	Traffic Control Barricades Type I	DAYS
643.0410	Traffic Control Barricades Type II	DAYS
643.0420	Traffic Control Barricades Type III	DAYS
643.0500	Traffic Control Flexible Tubular Marker Posts	EACH
643.0600	Traffic Control Flexible Tubular Marker Bases	EACH
643.0705	Traffic Control Warning Lights Type A	DAYS
643.0710	Traffic Control Warning Lights Type B	DAYS
643.0715	Traffic Control Warning Lights Type C	DAYS
643.0800	Traffic Control Arrow Boards	DAYS
643.0900	Traffic Control Signs	DAYS
643.1000	Traffic Control Signs Fixed Message	SF
643.2000	Traffic Control Detour (project)	EACH
643.3000	Traffic Control Detour Signs	DAYS
645.0105	Geotextile Fabric Type C	SY
645.0110	Geotextile Fabric Type DF	SY
645.0115	Geotextile Fabric Type ES	SY
645.0120	Geotextile Fabric Type HR	SY
645.0125	Geotextile Fabric Type MS	SY
645.0130	Geotextile Fabric Type R	SY
645.0135	Geotextile Fabric Type SR	SY
645.0140	Geotextile Fabric Type SAS	SY
646.0103	Pavement Marking Paint 4-Inch	LF
646.0106	Pavement Marking Epoxy 4-Inch	LF
646.0109	Pavement Marking Preformed Plastic 4-Inch	LF
646.0113	Pavement Marking Paint 6-Inch	LF
646.0116	Pavement Marking Epoxy 6-Inch	LF
646.0119	Pavement Marking Preformed Plastic 6-Inch	LF
646.0223	Pavement Marking Channelizing Paint 8-Inch	LF
646.0226	Pavement Marking Channelizing Epoxy 8-Inch	LF
646.0229	Pavement Marking Channelizing Preformed Plastic 8-Inch	LF
646.0403	Pavement Marking Same Day Paint 4-Inch	LF

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
646.0406	Pavement Marking Same Day Epoxy 4-Inch	LF
646.0413	Pavement Marking Same Day Paint 6-Inch	LF
646.0416	Pavement Marking Same Day Epoxy 6-Inch	LF
646.0600	Removing Pavement Markings	LF
646.0700	Raised Pavement Markers	EACH
646.0710	Raised Pavement Markers Replacement	EACH
646.0720	Raised Pavement Markers Replacement Lens	EACH
647.0105	Pavement Marking Railroad Crossings Paint	EACH
647.0110	Pavement Marking Railroad Crossings Epoxy	EACH
647.0115	Pavement Marking Railroad Crossings Preformed Plastic	EACH
647.0153	Pavement Marking Arrows Paint Type 1	EACH
647.0156	Pavement Marking Arrows Epoxy Type 1	EACH
647.0159	Pavement Marking Arrows Preformed Plastic Type 1	EACH
647.0163	Pavement Marking Arrows Paint Type 2	EACH
647.0166	Pavement Marking Arrows Epoxy Type 2	EACH
647.0169	Pavement Marking Arrows Preformed Plastic Type 2	EACH
647.0173	Pavement Marking Arrows Paint Type 3	EACH
647.0176	Pavement Marking Arrows Epoxy Type 3	EACH
647.0179	Pavement Marking Arrows Preformed Plastic Type 3	EACH
647.0183	Pavement Marking Arrows Paint Type 4	EACH
647.0186	Pavement Marking Arrows Epoxy Type 4	EACH
647.0189	Pavement Marking Arrows Preformed Plastic Type 4	EACH
647.0193	Pavement Marking Arrows Paint Type 5	EACH
647.0196	Pavement Marking Arrows Epoxy Type 5	EACH
647.0199	Pavement Marking Arrows Preformed Plastic Type 5	EACH
647.0203	Pavement Marking Arrows Bike Lane Paint	EACH
647.0206	Pavement Marking Arrows Bike Lane Epoxy	EACH
647.0209	Pavement Marking Arrows Bike Lane Preformed Plastic	EACH
647.0253	Pavement Marking Symbols Paint	EACH
647.0256	Pavement Marking Symbols Epoxy	EACH
647.0259	Pavement Marking Symbols Preformed Plastic	EACH
647.0303	Pavement Marking Symbols Bike Lane Paint	EACH
647.0306	Pavement Marking Symbols Bike Lane Epoxy	EACH
647.0309	Pavement Marking Symbols Bike Lane Preformed Plastic	EACH
647.0353	Pavement Marking Words Paint	EACH
647.0356	Pavement Marking Words Epoxy	EACH
647.0359	Pavement Marking Words Preformed Plastic	EACH
647.0403	Pavement Marking Words Bike Lane Paint	EACH
647.0406	Pavement Marking Words Bike Lane Epoxy	EACH
647.0409	Pavement Marking Words Bike Lane Preformed Plastic	EACH
647.0453	Pavement Marking Curb Paint	LF
647.0456	Pavement Marking Curb Epoxy	LF
647.0503	Pavement Marking Curb Ramp Paint	LF
647.0506	Pavement Marking Curb Ramp Epoxy	LF
647.0509	Pavement Marking Curb Ramp Preformed Plastic	LF
647.0553	Pavement Marking Stop Line Paint 12-Inch	LF
647.0556	Pavement Marking Stop Line Epoxy 12-Inch	LF
647.0559	Pavement Marking Stop Line Preformed Plastic 12-Inch	LF
647.0563	Pavement Marking Stop Line Paint 18-Inch	LF
647.0566	Pavement Marking Stop Line Epoxy 18-Inch	LF
647.0569	Pavement Marking Stop Line Preformed Plastic 18-Inch	LF
647.0573	Pavement Marking Stop Line Paint 24-Inch	LF
647.0576	Pavement Marking Stop Line Epoxy 24-Inch	LF
647.0579	Pavement Marking Stop Line Preformed Plastic 24-Inch	LF
647.0603	Pavement Marking Island Nose Paint	EACH
647.0606	Pavement Marking Island Nose Epoxy	EACH

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
647.0653	Pavement Marking Parking Stall Paint	LF
647.0656	Pavement Marking Parking Stall Epoxy	LF
647.0659	Pavement Marking Parking Stall Preformed Plastic	LF
647.0706	Pavement Marking Diagonal Epoxy 6-Inch	LF
647.0713	Pavement Marking Diagonal Paint 8-Inch	LF
647.0716	Pavement Marking Diagonal Epoxy 8-Inch	LF
647.0719	Pavement Marking Diagonal Preformed Plastic 8-Inch	LF
647.0723	Pavement Marking Diagonal Paint 12-Inch	LF
647.0726	Pavement Marking Diagonal Epoxy 12-Inch	LF
647.0729	Pavement Marking Diagonal Preformed Plastic 12-Inch	LF
647.0736	Pavement Marking Diagonal Epoxy 18-Inch	LF
647.0743	Pavement Marking Diagonal Paint 24-Inch	LF
647.0746	Pavement Marking Diagonal Epoxy 24-Inch	LF
647.0749	Pavement Marking Diagonal Preformed Plastic 24-Inch	LF
647.0763	Pavement Marking Crosswalk Paint 6-Inch	LF
647.0766	Pavement Marking Crosswalk Epoxy 6-Inch	LF
647.0769	Pavement Marking Crosswalk Preformed Plastic 6-Inch	LF
647.0773	Pavement Marking Crosswalk Paint 12-Inch	LF
647.0776	Pavement Marking Crosswalk Epoxy 12-Inch	LF
647.0779	Pavement Marking Crosswalk Preformed Plastic 12-Inch	LF
647.0783	Pavement Marking Crosswalk Paint 18-Inch	LF
647.0786	Pavement Marking Crosswalk Epoxy 18-Inch	LF
647.0789	Pavement Marking Crosswalk Preformed Plastic 18-Inch	LF
647.0803	Pavement Marking Aerial Enforcement Bars Epoxy 24-Inch	LF
647.0806	Pavement Marking Aerial Enforcement Bars Preformed Plastic 24-Inch	LF
647.0853	Pavement Marking Concrete Corrugated Median Paint	SF
647.0856	Pavement Marking Concrete Corrugated Median Epoxy	SF
647.0955	Removing Pavement Markings Arrows	EACH
647.0960	Removing Pavement Markings Symbols	EACH
647.0965	Removing Pavement Markings Words	EACH
648.0100	Locating No-Passing Zones	MI
649.0100	Temporary Pavement Marking 4-Inch	LF
649.0200	Temporary Pavement Marking Reflective Paint 4-Inch	LF
649.0300	Temporary Pavement Marking Reflective Tape 4-Inch	LF
649.0400	Temporary Pavement Marking Removable Tape 4-Inch	LF
649.0700	Temporary Pavement Marking Channelizing 8-Inch	LF
649.0800	Temporary Pavement Marking Channelizing Removable Tape 8-Inch	LF
649.0900	Temporary Pavement Marking Stop Line 12-Inch	LF
649.1000	Temporary Pavement Marking Stop Line Removable Tape 12-Inch	LF
649.1100	Temporary Pavement Marking Stop Line 18-Inch	LF
649.1200	Temporary Pavement Marking Stop Line Removable Tape 18-Inch	LF
649.1300	Temporary Pavement Marking Stop Line 24-Inch	LF
649.1400	Temporary Pavement Marking Stop Line Removable Tape 24-Inch	LF
649.1500	Temporary Pavement Marking Diagonal 12-Inch	LF
649.1600	Temporary Pavement Marking Diagonal Removable Tape 12-Inch	LF
649.1700	Temporary Pavement Marking Arrows	EACH
649.1800	Temporary Pavement Marking Arrows Removable Tape	EACH
649.1900	Temporary Pavement Marking Words	EACH
649.2000	Temporary Pavement Marking Words Removable Tape	EACH
649.2100	Temporary Raised Pavement Markers	EACH
650.4000	Construction Staking Storm Sewer System	EACH
650.4500	Construction Staking Subgrade	LF
650.5000	Construction Staking Base	LF
650.5500	Construction Staking Curb Gutter and Curb & Gutter	LF
650.6000	Construction Staking Pipe Culverts	EACH
650.6500	Construction Staking Structure Layout (structure)	LS

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
650.7000	Construction Staking Concrete Pavement	LF
650.7500	Construction Staking Concrete Barrier	LF
650.8000	Construction Staking Resurfacing Reference	LF
650.8500	Construction Staking Electrical Installations (project)	LS
650.9900	Construction Staking Initial Layout	LF
652.0105	Conduit Rigid Metallic 3/4-Inch	LF
652.0110	Conduit Rigid Metallic 1-Inch	LF
652.0115	Conduit Rigid Metallic 1 1/4-Inch	LF
652.0120	Conduit Rigid Metallic 1 1/2-Inch	LF
652.0125	Conduit Rigid Metallic 2-Inch	LF
652.0130	Conduit Rigid Metallic 2 1/2-Inch	LF
652.0135	Conduit Rigid Metallic 3-Inch	LF
652.0140	Conduit Rigid Metallic 3 1/2-Inch	LF
652.0145	Conduit Rigid Metallic 4-Inch	LF
652.0205	Conduit Rigid Nonmetallic Schedule 40 3/4-Inch	LF
652.0210	Conduit Rigid Nonmetallic Schedule 40 1-Inch	LF
652.0215	Conduit Rigid Nonmetallic Schedule 40 1 1/4-Inch	LF
652.0220	Conduit Rigid Nonmetallic Schedule 40 1 1/2-Inch	LF
652.0225	Conduit Rigid Nonmetallic Schedule 40 2-Inch	LF
652.0230	Conduit Rigid Nonmetallic Schedule 40 2 1/2-Inch	LF
652.0235	Conduit Rigid Nonmetallic Schedule 40 3-Inch	LF
652.0240	Conduit Rigid Nonmetallic Schedule 40 4-Inch	LF
652.0305	Conduit Rigid Nonmetallic Schedule 80 3/4-Inch	LF
652.0310	Conduit Rigid Nonmetallic Schedule 80 1-Inch	LF
652.0315	Conduit Rigid Nonmetallic Schedule 80 1 1/4-Inch	LF
652.0320	Conduit Rigid Nonmetallic Schedule 80 1 1/2-Inch	LF
652.0325	Conduit Rigid Nonmetallic Schedule 80 2-Inch	LF
652.0330	Conduit Rigid Nonmetallic Schedule 80 2 1/2-Inch	LF
652.0335	Conduit Rigid Nonmetallic Schedule 80 3-Inch	LF
652.0340	Conduit Rigid Nonmetallic Schedule 80 4-Inch	LF
652.0405	Conduit Reinforced Thermosetting Resin 2-Inch	LF
652.0410	Conduit Reinforced Thermosetting Resin 3-Inch	LF
652.0415	Conduit Reinforced Thermosetting Resin 4-Inch	LF
652.0605	Conduit Special 2-Inch	LF
652.0610	Conduit Special 2 1/2-Inch	LF
652.0615	Conduit Special 3-Inch	LF
652.0620	Conduit Special 3 1/2-Inch	LF
652.0625	Conduit Special 4-Inch	LF
652.0690	Conduit Special (inch)	LF
652.0705	Drain Duct 2-Inch	LF
652.0800	Conduit Loop Detector	LF
652.0900	Loop Detector Slots	LF
653.0105	Pull Boxes Steel 12x24-Inch	EACH
653.0110	Pull Boxes Steel 12x30-Inch	EACH
653.0115	Pull Boxes Steel 12x36-Inch	EACH
653.0120	Pull Boxes Steel 18x24-Inch	EACH
653.0125	Pull Boxes Steel 18x30-Inch	EACH
653.0130	Pull Boxes Steel 18x36-Inch	EACH
653.0135	Pull Boxes Steel 24x36-Inch	EACH
653.0140	Pull Boxes Steel 24x42-Inch	EACH
653.0145	Pull Boxes Steel 24x48-Inch	EACH
653.0180	Pull Boxes Steel Communications (inch)	EACH
653.0208	Junction Boxes 8x8x8-Inch	EACH
653.0220	Junction Boxes 18X6X6-Inch	EACH
653.0222	Junction Boxes 18X12X6-Inch	EACH
654.0101	Concrete Bases Type 1	EACH

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
654.0102	Concrete Bases Type 2	EACH
654.0105	Concrete Bases Type 5	EACH
654.0106	Concrete Bases Type 6	EACH
654.0107	Concrete Bases Type 7	EACH
654.0108	Concrete Bases Type 8	EACH
654.0109	Concrete Bases Type 9	EACH
654.0110	Concrete Bases Type 10	EACH
654.0111	Concrete Bases Type 11	EACH
654.0200	Concrete Control Cabinet Bases Type 6	EACH
654.0205	Concrete Control Cabinet Bases Type 7	EACH
654.0210	Concrete Control Cabinet Bases Type 8	EACH
654.0215	Concrete Control Cabinet Bases Type 9	EACH
654.0217	Concrete Control Cabinet Bases Type 9 Special	EACH
654.0220	Concrete Control Cabinet Bases Type 10	EACH
655.0102	Cable In Duct 2-2 AWG	LF
655.0104	Cable In Duct 2-4 AWG	LF
655.0106	Cable In Duct 2-6 AWG	LF
655.0108	Cable In Duct 2-8 AWG	LF
655.0110	Cable In Duct 2-10 AWG	LF
655.0122	Cable In Duct 3-2 AWG	LF
655.0124	Cable In Duct 3-4 AWG	LF
655.0126	Cable In Duct 3-6 AWG	LF
655.0128	Cable In Duct 3-8 AWG	LF
655.0130	Cable In Duct 3-10 AWG	LF
655.0144	Cable In Duct 4-4 AWG	LF
655.0146	Cable In Duct 4-6 AWG	LF
655.0148	Cable In Duct 4-8 AWG	LF
655.0150	Cable In Duct 4-10 AWG	LF
655.0205	Cable Traffic Signal 3-12 AWG	LF
655.0210	Cable Traffic Signal 3-14 AWG	LF
655.0215	Cable Traffic Signal 4-12 AWG	LF
655.0220	Cable Traffic Signal 4-14 AWG	LF
655.0223	Cable Traffic Signal 5-10 AWG	LF
655.0225	Cable Traffic Signal 5-12 AWG	LF
655.0230	Cable Traffic Signal 5-14 AWG	LF
655.0233	Cable Traffic Signal 7-10 AWG	LF
655.0235	Cable Traffic Signal 7-12 AWG	LF
655.0240	Cable Traffic Signal 7-14 AWG	LF
655.0243	Cable Traffic Signal 9-10 AWG	LF
655.0245	Cable Traffic Signal 9-12 AWG	LF
655.0250	Cable Traffic Signal 9-14 AWG	LF
655.0253	Cable Traffic Signal 12-10 AWG	LF
655.0255	Cable Traffic Signal 12-12 AWG	LF
655.0260	Cable Traffic Signal 12-14 AWG	LF
655.0263	Cable Traffic Signal 15-10 AWG	LF
655.0265	Cable Traffic Signal 15-12 AWG	LF
655.0270	Cable Traffic Signal 15-14 AWG	LF
655.0273	Cable Traffic Signal 19-10 AWG	LF
655.0275	Cable Traffic Signal 19-12 AWG	LF
655.0280	Cable Traffic Signal 19-14 AWG	LF
655.0285	Cable Traffic Signal 21-12 AWG	LF
655.0290	Cable Traffic Signal 21-14 AWG	LF
655.0305	Cable Type UF 2-12 AWG Grounded	LF
655.0310	Cable Type UF 2-12 AWG	LF
655.0315	Cable Type UF 2-10 AWG	LF
655.0400	Communication Cable Plowed	LF

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
655.0405	Communication Cable Trenched	LF
655.0410	Communication Cable Installed in Conduit	LF
655.0505	Electrical Wire Traffic Signals 14 AWG	LF
655.0510	Electrical Wire Traffic Signals 12 AWG	LF
655.0515	Electrical Wire Traffic Signals 10 AWG	LF
655.0520	Electrical Wire Traffic Signals 8 AWG	LF
655.0525	Electrical Wire Traffic Signals 6 AWG	LF
655.0530	Electrical Wire Traffic Signals 4 AWG	LF
655.0535	Electrical Wire Traffic Signals 2 AWG	LF
655.0610	Electrical Wire Lighting 12 AWG	LF
655.0615	Electrical Wire Lighting 10 AWG	LF
655.0620	Electrical Wire Lighting 8 AWG	LF
655.0625	Electrical Wire Lighting 6 AWG	LF
655.0630	Electrical Wire Lighting 4 AWG	LF
655.0635	Electrical Wire Lighting 2 AWG	LF
655.0640	Electrical Wire Lighting 1 AWG	LF
655.0645	Electrical Wire Lighting 1/0 AWG	LF
655.0700	Loop Detector Lead In Cable	LF
655.0800	Loop Detector Wire	LF
656.0100	Electrical Service Meter Socket (location)	LS
656.0200	Electrical Service Meter Breaker Pedestal (location)	LS
656.0300	Electrical Service Unmetered (location)	LS
656.0400	Electrical Service Main Lugs Only Meter Pedestal (location)	LS
656.0500	Electrical Service Breaker Disconnect Box (location)	LS
657.0100	Pedestal Bases	EACH
657.0205	Transformer Bases Breakaway 13-15 Inch Bolt Circle	EACH
657.0210	Transformer Bases Breakaway 15-17 Inch Bolt Circle	EACH
657.0255	Transformer Bases Standard 11 1/2-Inch Bolt Circle	EACH
657.0315	Poles Type 4	EACH
657.0320	Poles Type 5	EACH
657.0325	Poles Type 6	EACH
657.0330	Poles Type 7-TD2	EACH
657.0335	Poles Type 7	EACH
657.0340	Poles Type 8	EACH
657.0345	Poles Type 9	EACH
657.0350	Poles Type 10	EACH
657.0355	Poles Type 12	EACH
657.0360	Poles Type 13	EACH
657.0375	Poles Type A	EACH
657.0380	Poles Type E	EACH
657.0405	Traffic Signal Standards Aluminum 3.5-FT	EACH
657.0410	Traffic Signal Standards Aluminum 9-FT	EACH
657.0415	Traffic Signal Standards Aluminum 11-FT	EACH
657.0420	Traffic Signal Standards Aluminum 13-FT	EACH
657.0425	Traffic Signal Standards Aluminum 15-FT	EACH
657.0430	Traffic Signal Standards Aluminum 10-FT	EACH
657.0515	Monotube Arms 15-FT	EACH
657.0520	Monotube Arms 20-FT	EACH
657.0525	Monotube Arms 25-FT	EACH
657.0530	Monotube Arms 30-FT	EACH
657.0535	Monotube Arms 35-FT	EACH
657.0540	Monotube Arms 40-FT	EACH
657.0545	Monotube Arms 45-FT	EACH
657.0550	Monotube Arms 50-FT	EACH
657.0555	Monotube Arms 55-FT	EACH
657.0605	Luminaire Arms Single Member 4 1/2-Inch Clamp 4-FT	EACH

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
657.0610	Luminaire Arms Single Member 4 1/2-Inch Clamp 6-FT	EACH
657.0615	Luminaire Arms Single Member 4 1/2-Inch Clamp 8-FT	EACH
657.0620	Luminaire Arms Single Member 6-Inch Clamp 4-FT	EACH
657.0625	Luminaire Arms Single Member 6-inch Clamp 6-FT	EACH
657.0630	Luminaire Arms Single Member 6-Inch Clamp 8-FT	EACH
657.0635	Luminaire Arms Single Member 6-Inch Clamp 10-FT	EACH
657.0640	Luminaire Arms Single Member 6-Inch Clamp 15-FT	EACH
657.0705	Luminaire Arms Truss Type 4 1/2-Inch Clamp 10-FT	EACH
657.0710	Luminaire Arms Truss Type 4 1/2-Inch Clamp 12-FT	EACH
657.0715	Luminaire Arms Truss Type 4 1/2-Inch Clamp 15-FT	EACH
657.0720	Luminaire Arms Truss Type 6-Inch Clamp 20-FT	EACH
657.0725	Luminaire Arms Truss Type 6-inch Clamp 15-FT	EACH
657.0730	Luminaire Arms Truss Type 6-inch Clamp 12-FT	EACH
657.0735	Luminaire Arms Truss Type 6-inch Clamp 10-FT	EACH
658.0105	Traffic Signal Face 1-12 Inch 2-8 Inch Vertical	EACH
658.0110	Traffic Signal Face 3-12 Inch Vertical	EACH
658.0115	Traffic Signal Face 4-12 Inch Vertical	EACH
658.0120	Traffic Signal Face 5-12 Inch Vertical	EACH
658.0155	Traffic Signal Face 3-12 Inch Horizontal	EACH
658.0160	Traffic Signal Face 4-12 Inch Horizontal	EACH
658.0165	Traffic Signal Face 5-12 Inch Horizontal	EACH
658.0205	Backplates Signal Face 1 section 8-Inch	EACH
658.0210	Backplates Signal Face 1 section 12-Inch	EACH
658.0215	Backplates Signal Face 3 section 12-Inch	EACH
658.0220	Backplates Signal Face 4 section 12-Inch	EACH
658.0225	Backplates Signal Face 5 section 12-Inch	EACH
658.0300	Backplates Signal Face 12-8-8 Inch	EACH
658.0412	Pedestrian Signal Face 12-Inch	EACH
658.0500	Pedestrian Push Buttons	EACH
658.5069	Signal Mounting Hardware (location)	LS
659.0105	Luminaires Utility HPS 70 Watts	EACH
659.0110	Luminaires Utility HPS 100 Watts	EACH
659.0115	Luminaires Utility HPS 150 Watts	EACH
659.0120	Luminaires Utility HPS 200 Watts	EACH
659.0125	Luminaires Utility HPS 250 Watts	EACH
659.0130	Luminaires Utility HPS 310 Watts	EACH
659.0135	Luminaires Utility HPS 400 Watts	EACH
659.0150	Luminaires Utility MH 250 Watts	EACH
659.0205	Luminaires Underdeck 70 Watts	EACH
659.0210	Luminaires Underdeck 100 Watts	EACH
659.0215	Luminaires Underdeck 150 Watts	EACH
659.0300	Luminaires Sign Lighting	EACH
659.0400	Luminaires High Mast Lighting	EACH
659.0500	Sign Lighting (location)	LS
659.0600	Underdeck Lighting (location)	LS
659.0700	Lighting Units Walkway	EACH
659.0802	Plaques Sequence Identification	EACH
660.0100	High Mast Foundation (location)	LS
660.0200	High Mast Lighting Tower (location)	LS
661.0100	Temporary Traffic Signals for Bridges (structure)	LS
661.0200	Temporary Traffic Signals for Intersections (location)	LS
661.0300	Generators	DAY
661.0700	Temporary Ramp Meter (location)	LS
670.0100	Field System Integrator	LS
670.0200	ITS Documentation	LS
671.0100	Conduit HDPE 4 Duct 1 1/4 Inch	LF

SCHEDULE OF BID ITEMS

Item Number	Description	Unit
671.0200	Conduit HDPE Directional Bore 4-Duct 1 1/4-Inch	LF
671.0300	Fiber Optic Cable Marker	EACH
672.0100	Base ITS Controller Cabinet	EACH
672.0230	Base Camera Pole 30-FT	EACH
672.0250	Base Camera Pole 50-FT	EACH
672.0280	Base Camera Pole 80-FT	EACH
673.0105	Communication Vault Type 1	EACH
674.0106	Cable ITS Communication 6 Pair	LF
674.0112	Cable ITS Communication 12 Pair	LF
674.0125	Cable ITS Communication 25 Pair	LF
674.0200	Cable Microwave Detector	LF
674.0300	Remove Cable	LF
674.0400	Reinstall Cable	LF
675.0100	Install Controller Ramp Meter Processor Assembly	EACH
675.0200	Install Controller Detector Processor Assembly	EACH
675.0300	Install Mounted Controller Microwave Detector Assembly	EACH
676.0100	Signal Assembly Ramp Control Sidemount	EACH
676.0105	Signal Assembly Ramp Control Overhead	EACH
676.0200	Signal Assembly Display Enforcement	EACH
676.0300	Signal Assembly Advance Flasher Type 1	EACH
676.0305	Signal Assembly Advance Flasher Type 2	EACH
677.0100	Install Camera Pole	EACH
677.0200	Install Camera Assembly	EACH
678.0006	Install Fiber Optic Cable Outdoor Plant 6-CT	LF
678.0024	Install Fiber Optic Cable Outdoor Plant 24-CT	LF
678.0036	Install Fiber Optic Cable Outdoor Plant 36-CT	LF
678.0048	Install Fiber Optic Cable Outdoor Plant 48-CT	LF
678.0072	Install Fiber Optic Cable Outdoor Plant 72-CT	LF
678.0096	Install Fiber Optic Cable Outdoor Plant 96-CT	LF
678.0144	Install Fiber Optic Cable Outdoor Plant 144-CT	LF
678.0200	Fiber Optic Splice Enclosure	EACH
678.0300	Fiber Optic Splice	EACH
678.0400	Fiber Optic Termination	EACH
678.0500	Communication System Testing	LS
690.0100	Sawing Existing Pavement	LF
690.0200	Sawing Concrete Pavement Full Depth	LF

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CONVERSION TABLE U.S. STANDARD MEASURE TO SI METRIC

TO CONVERT	FROM U.S. STANDARD UNIT	TO SI METRIC UNIT	MULTIPLY BY
Length	inch	millimeter	25.4
	linear foot	millimeter	304.8
	linear foot	meter	0.3048
	station	meter	30.48
	station	40 meter unit	0.762
	mile	kilometer	1.609344
Area	square inch	square millimeter	645.16
	square foot	square meter	0.092903
	square yard	square meter	0.836127
	acre	square meter	4046.87
	acre	hectare	0.404687
Volume	fluid ounce	millimeter	29.57353
	gallon	liter	3.785412
	1000 gallons	kiloliter	2.785412
	cubic foot	cubic meter	0.028317
	cubic yard	cubic meter	0.764555
	1000 board feet	cubic meter	2.359737
Weight	ounce	gram	28.350
	pound	kilogram	0.453592
	hundredweight	kilogram	45.359237
	ton	megagram	0.907185
Wt./unit length	pound/linear foot	kilogram/meter	1.48816
Wt./unit area	pound/square foot	kilogram/square meter	4.88243
Density	pound/cubic foot	kilogram/cubic meter	16.0185
Force	pound	newton	4.44822
Force/unit length	pound/linear foot	newton/meter	14, 5939
Work	foot pound force	joule	1.35582
Pressure	pound/square foot	pascal	47.8803
	kip/square foot	kilopascal	47.8803
	pound/square inch	kilopascal	6.89476
	kip/square inch	megapascal	6.89476
Temperature	degree fahrenheit	degree celsius	(F-32)x5/9
Bending moment	foot pound	newton meter	1.35582
Plane angle	degree	degree	1
Electrical	ampere	ampere	1
	volt	volt	1
	watt	watt	1
Illuminance	footcandle	lux	10.7639
Miscellaneous:			
Clear/grub	inch diameter	25 mm diameter unit	1.016
Hauling	cubic yard mile	cubic meter kilometer	1.230432
Overhaul	yard mile	cubic meter kilometer	1.230432
Speed	mile/hour	kilometer/hour	1.609344

STANDARD SIEVE SIZES

U.S. STANDARD	SI METRIC
5 inch	125 millimeters
3 inch	75 millimeters
2 inch	50 millimeters
1 1/2 inch	37.5 millimeters
1 inch	25.0 millimeters
3/4 inch	19.0 millimeters
1/2 inch	12.5 millimeters
3/8 inch	9.5 millimeters
No. 4	4.75 millimeters
No. 8	2.36 millimeters
No. 10	2.00 millimeters
No. 16	1.18 millimeters
No. 30	600 microns ^[1]
No. 40	425 microns
No. 50	300 microns
No. 100	150 microns
No. 200	75 microns
No. 325	45 microns

^[1] 1 micron = 1/1000 millimeter

BID ITEM UNIT ABBREVIATIONS

ACRE	acre	LS	lump sum
AD	arrow day	MBM	1000 foot board measure
BBL	barrel	MGAL	1000 gallon unit
BD	board day	MI	mile
CF	cubic foot	MKFT	board foot
CWT	hundredweight	MON	month
CY	cubic yard	NONE	none
CYMI	cubic yard mile	OZ	ounce
DAY	day	PD	person day
DD	drum day	SACK	sack
DOL	dollar	SD	sign day
EACH	each	SF	square foot
FA	Fuel cost adjustments	STA	station
GAL	gallon	STYD	station yard
HRS	hours	SY	square yard
ID	Inch diameter	TD	ton day
GAL	gallon	TM	ton mile
ID	inch diameter	TON	ton
LB	pound	VF	vertical feet
LF	linear foot	WD	working day
LM	linear mile	WK	week
LOT	lot	YDMI	yard mile

CONVERSION TABLE SI METRIC TO U.S. STANDARD MEASURE

TO CONVERT	FROM SI METRIC UNIT	TO U.S. STANDARD UNIT	MULTIPLY BY
Length	millimeter	inch	0.039370
	millimeter	linear foot	0.0032808
	meter	linear foot	3.280840
	meter	station	0.032808
	40 meter unit	station	1.312336
	kilometer	mile	0.621371
Area	square millimeter	square inch	0.001550
	square meter	square foot	10.763910
	square meter	square yard	1.195990
	square meter	acre	0.0002471
	hectare	acre	2.471044
Volume	milliliter	fluid ounce	0.033814
	liter	gallon	0.264172
	kiloliter	1000 gallons	0.264172
	cubic meter	cubic foot	35.314667
	cubic meter	cubic yard	1.307951
	cubic meter	1000 board feet	0.423776
Mass	gram	ounce	0.035274
	kilogram	pound	2.204622
	kilogram	hundredweight	0.022046
	megagram	ton	1.102311
Mass/unit length	kilogram/meter	pound/linear foot	0.671971
Mass/unit area	kilogram/square meter	pound/square foot	0.671971
Mass density	kilogram/cubic meter	pound/cubic foot	0.062428
Force	newton	pound	0.224809
Force/unit length	newton/meter	pound/linear foot	0.068522
Work	joule	foot pound force	0.737561
Pressure	pascal	pound/square foot	0.020885
	kilopascal	kip/.square foot	0.020885
	kilopascal	pound/square inch	0.145038
	megapascal	kip/square inch	0.145038
Temperature	degree celsius	degree fahrenheit	$(C \times 9/5) + 32$
Bending moment	newton meter	foot-pound	0.737561
Plane angle	degree	degree	1
Electrical	ampere	ampere	1
	volt	volt	1
	watt	watt	1
Illuminance	lux	footcandle	0.092903
Miscellaneous:			
Clear/grub	25 mm diameter unit	inch diameter	0.984252
Hauling	cubic meter kilometer	yard mile	0.812723
Overhaul	cubic meter kilometer	cubic yard mile	0.812723
Speed	kilometer/hour	mile/hour	0.621371

SI METRIC ABBREVIATIONS

A	ampere	mm	millimeter
C	degrees celsius	mm ²	square millimeter
g	gram	m ² , m ²	square meter
h	hour	m ³ , m ³	cubic meter
ha	hectare	m ³ km	cubic meter kilometer
J	joule	Mg	megagram (metric ton)
kg	kilogram	MPa	megapascal
kL	kiloliter	N	newton
km	kilometer	N•m	newton meter
kPa	kilopascal	P	pascal
L	liter	s	second
lx	lux	V	volt
m	meter	W	watt
m	meter	25mm	25 millimeter diameter unit
mg	milligram	40m	40 meter unit
mL	milliliter	μm	micron