

Standard Specifications for Road and Bridge Construction

Volume 1 of 2



Prepared by

**NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
BISMARCK, NORTH DAKOTA**

www.dot.nd.gov

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Adopted October 2008

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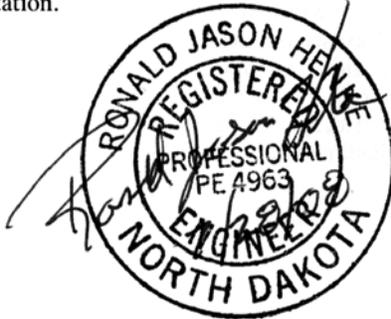
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I hereby certify that this Standard Specifications Book was prepared by me or under my responsible charge, compiled from specifications prepared, examined, adopted and implemented by the North Dakota Department of Transportation in accordance with established procedures, and as approved by the Federal Highway Administration. This document was originally issued and sealed by Ronald Jason Henke, Registration number PE-4963 on 07/29/08 and the original document is stored at the North Dakota Department of Transportation.



These North Dakota Department of Transportation Standard Specifications for Road and Bridge Construction, 2008, are hereby approved for application on highway and related constructions contracts as referenced in the contract plans or specifications, and they shall apply as noted and amended by those documents.

Approved,

A handwritten signature in cursive script that reads "Grant Levi".

Grant Levi, P.E.
Deputy Director for Engineering

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Working titles having a masculine gender, such as workman, workmen, and foreman, and pronouns such as he, his, and him are utilized in these Specifications for the sake of brevity and are intended to refer to persons of either sex.

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SECTION 101 ABBREVIATIONS AND DEFINITIONS

Wherever the following abbreviations or terms are used in these Specifications, the Plans, or other Contract documents, their meaning shall be as follows:

101.01 ABBREVIATIONS.

AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
AC	Asphaltic Cement
ACI	American Concrete Institute
ADA	Americans with Disabilities Act
AGC	Associated General Contractors of America
AIA	American Institute of Architects
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute, Inc.
ARA	American Railway Association
AREMA	American Railway Engineering and Maintenance-of-Way Association
ARTBA	American Road and Transportation Builders Association
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects
ASTM	American Society for Testing and Materials
ATSSA	American Traffic Safety Services Association
AWPA	American Wood Preservers Association
AWWA	American Water Works Association
AWS	American Welding Society
BIA	Bureau of Indian Affairs
BMP	Best Management Practices
CADD	Computer-Aided Drafting Design
CARS	Construction Automated Records System
COE	Corps of Engineers
CFR	Code of Federal Regulations
CMC	County Major Collector
CPM	Critical Path Method
CRS	County Rural Society
CRSI	Concrete Reinforcing Steel Institute
DBE	Disadvantaged Business Enterprise
EEO	Equal Employment Opportunity
ESAL	Equivalent Single Axle Load
EPA	Environmental Protection Agency

FAA	Federal Aviation Administration
FHWA	Federal Highway Administration, Department of Transportation
FSS	Federal Specifications and Standards, General Services Administration
MUTCD	Manual on Uniform Traffic Control Devices
NDCC	North Dakota Century Code
NDDOT	North Dakota Department of Transportation
NEMA	National Electric Manufacturer's Association
NEPA	National Environmental Policy Act
NHTSA	National Highway Traffic Safety Administration
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCC	Portland Cement Concrete
PCI	Prestressed Concrete Institute
PVC	Polyvinylchloride - PVC Pipe
QA	Quality Assurance
QC	Quality Control
SAE	Society of Automotive Engineers
SG	Specific Gravity
SHPO	State Historic Preservation Officer
SSPC	Steel Structures Painting Council
UL	Underwriters Laboratory, Inc.
USFWS	U.S. Fish and Wildlife Service
VMA	Voids in Mineral Aggregate

101.02 DEFINITIONS.

Act of God. An unforeseeable act, event, or happening resulting from natural causes such as earthquake, tornado, or other cataclysmic phenomena.

Addendum. Contract revisions developed after advertisement of bids and before bid opening.

Advertisement. The public announcement inviting bids for work to be performed or materials to be furnished.

Award. The Department's acceptance of a Proposal.

Base Course. The layer or layers of specified or selected material placed on a subbase or subgrade to support a surface course.

Bidder. An individual, or legal entity submitting a Proposal.

Bid Documents. All writings, working papers, computer printouts, charts, and all other data compilation which contain or reflect information, data, or calculations used by the Bidder to determine the bid proposal submitted, including but not limited to material relating to the determination and application of:

- equipment rates
- overhead rates and related time schedules
- labor rates
- efficiency or productivity factors

arithmetic extensions
 Subcontractor and material supplier quotations

Manuals which are standard to the industry may be included in the bid documentation by reference and will show the name and date of the publication and the Publisher.

Bid Opening. The public opening of bid proposals submitted at the prescribed time and date meeting Department requirements and procedures.

Bid Schedule (also known as the Schedule of Items). A list of the bid items and estimated quantities in the Proposal.

Bridge. A single-span or multiple-span structure including supports, erected over a depression or obstruction such as water, highway, or railway; and having a track or passageway for carrying traffic or other moving loads; and having a length measured along the center of roadway of more than 20 feet between undercopings of abutments or extreme ends of openings for multiple boxes.

Bridge Length. The greater dimension of a structure measured along the center of the roadway between backs of abutment walls or between ends of bridge deck.

Bridge Roadway Width. The clear width of a structure measured at right angles to the center of the roadway between the bottom of curbs or, if curbs are not used, between the inner faces of parapet or railing.

Calendar Day. Every day shown on the calendar including Sundays and holidays. A day begins and ends at midnight.

Change Order. A written order from the Department to the Contractor, covering changes in Contract documents, for Extra Work within the scope of the Contract, and for establishing the basis of payment or time adjustments for work affected by the changes. This may include, for example, additional items of work or an adjustment in unit prices. When the work involved necessitates an adjustment in the Contract terms, it must be signed by the Contractor and Engineer, or his representative, before it becomes effective. A Change Order signed by all parties to the Contract is a supplemental agreement.

Claim. A written request or demand for something due or believed to be due.

Clue. A potential source of aggregate material identified in the Proposal and, if used, is considered a Contractor-furnished material source.

Completion. The project is complete when all work under the Contract has been satisfactorily completed and is open to traffic or available for use by the traveling public; and the Project is in condition for final acceptance.

Conformity. Compliance with reasonable and customary manufacturing and construction tolerances where working tolerances are not specified. Where working tolerances are specified, conformity means compliance with such tolerances.

Contract. The written agreement between the Department and the Contractor setting forth the obligations of the parties for the performance of the prescribed work.

The Contract includes: the Proposal, Contract Form and Contract Bond, Specifications, Supplemental Specifications, Special Provisions, Standard Drawings, general

and detailed Plans, work drawings, any Change Orders and Supplemental Agreements required to complete the work and authorized extensions of time.

Contract Bond. The security, executed by the Contractor and the Surety or Sureties, furnished to the Department to guarantee complete execution of the Contract and all Supplemental Agreements and the payment of all legal debts pertaining to project construction.

Contract Item (Pay Item). A specific unit of work for which a price is provided in the Contract.

Contract Time. The number of work days, calendar days, a combination of the two, or a final calendar date allowed for completion of the Contract including authorized time extensions.

Contractor. The individual, or legal entity contracting with the Department for performance of prescribed work.

County. The jurisdiction or jurisdictions in which the work is located.

Critical Path Method. An electronic system of planning, scheduling, and control which combines all relevant information into a single master plan, permitting the establishment of the optimum sequence and duration of operations; utilizing an arrow diagram drawn to show the interconnected individual tasks involved in constructing the Project.

Culvert. Any structure under the roadway with a clear opening of 20 feet or less measured along the center of the roadway.

Department. The North Dakota Department of Transportation (NDDOT) or its representatives.

Digital Identification. A unique number issued by the Department and assigned to Contractors for security and identification purposes.

Director. The Director of the North Dakota Department of Transportation acting directly or through authorized representatives.

Divided Highway. A highway with separated roadways for traffic in opposite directions.

Driving Lane. The portion of the highway, excluding shoulders, normally used to accommodate the movement of vehicular traffic.

Employee. Any person working on the Project covered by the Contract who is under the direction or control of, or receives compensation from the Contractor or Subcontractor.

Engineer. The Deputy Director for Engineering of the Department, acting directly or through an authorized representative who is responsible for engineering supervision of construction.

Equipment. All machinery, tools, apparatus, and supplies necessary for the upkeep, maintenance, construction, and completion of the Project.

Expressway. A divided arterial highway for through traffic with full or partial control of access and generally with grade separations at intersections.

Extra Work. Work not provided for in the Contract but considered essential by the Engineer for satisfactory completion of the Contract within its intended scope.

Extra Work Order. A Change Order for the performance of work or furnishing of materials involving Extra Work at agreed prices or on a Force Account basis.

Federal-Aid Project. A Project which is constructed entirely or partially with Federal Funds.

Field Engineer. An authorized person who is in charge of a Project and reports to the Engineer.

Fog Coat. A thin application of bitumen applied to the pavement surface, with or without a sand coating.

Force Account. Payment for extra work on the basis of actual costs plus approved additives.

Fractured Material. Aggregate crushed to a smaller size from a larger size. (i.e. aggregate retained on a 5/8 inch sieve crushed to produce aggregate of 1/2 inch or less in size.)

Freeway. An expressway with full control of access.

Frontage Street or Road. A local street or road located along side a highway for service to abutting property, adjacent areas and for control of access.

Geosynthetic. A product manufactured from a polymeric material used with soil, rock, earth, or other geotechnical engineering-related material as an integral part of a man-made project, structure, or system.

Geotextile. A permeable geosynthetic made of textile materials, ie: separation, drainage, riprap, and reinforcement fabrics.

Geogrid. A geosynthetic formed by a regular network of integrally connected elements with apertures greater than 1/4 inch to allow interlocking with surrounding soil, rock, earth, and other surrounding materials to primarily function as reinforcement.

Grade Separation. A crossing of two highways, or a highway and a railroad, at different levels.

Highway, Street, or Road. A general term indicating a public way used by vehicles and pedestrians. Includes entire area within the Right of Way.

Holidays. State of North Dakota holidays are as follows:

Every Sunday.

The first day of January, which is New Year's Day.

The third Monday of January, which is Martin Luther King Day.

The third Monday of February, which is President's Day.
 The Friday just before Easter Sunday and commonly known as Good Friday.
 The last Monday in May, which is Memorial Day.
 The fourth day of July, which is the anniversary of the Declaration of Independence.
 The first Monday in September, which is Labor Day.
 The eleventh day of November, which is Veteran's Day.
 The fourth Thursday in November, which is Thanksgiving Day.
 The twenty-fifth of December, which is Christmas Day.
 Every day appointed by the President of the United States or by the Governor of this State as a public holiday.

When a holiday falls on a Saturday, the preceding Friday shall be the holiday; or, when a holiday falls on a Sunday, the following Monday shall be the holiday.

The twenty-fourth of December, Christmas Eve day, will be a half-day holiday when it falls on a Monday, Tuesday, Wednesday, and Thursday. State offices will close at 12 noon that day.

Incentive/Disincentive Provisions. An adjustment to the Contract price of a predetermined amount for each day the work is completed ahead of or behind the specified milestone, phase, or Contract completion dates.

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

Invitation for Bids. The advertisement for Proposals for work or materials on which bids are requested. The advertisement will indicate, with reasonable accuracy the quantity and location of work to be performed, the character and quantity of material to be furnished, and the time and place of the opening of Proposals.

Laboratory. The testing laboratory of the Department or any other testing laboratory designated by the Engineer.

Major and Minor Contract Items. A major item is any Contract item having a Contract value in excess of 5 percent of the total original Contract amount. All other items are minor items.

Minor items in the original Proposal shall become major items when the total cost increases to at least 5 percent of the total original Contract amount.

Materially Unbalanced Bid. A bid in which there is a reasonable doubt that award to the Bidder submitting the mathematically unbalanced bid will result in the lowest ultimate cost to the Department.

Materials. Any substances specified for use in constructing the Project.

Mathematically Unbalanced Bid. A bid containing lump sum or unit bid items which do not reflect reasonable actual costs plus a reasonable proportionate share of the Bidder's anticipated profit, overhead costs, and other indirect costs, which he/she anticipates for the performance of the items in question.

Median. The portion of a divided highway separating the traveled ways.

M Gal. 1,000 gallons.

Notice to Bidders. A notice issued by the Department of projects available for bid in an upcoming Bid Opening.

Notice to Proceed. A written notice to the Contractor to begin the Contract work; or, in lieu of such written notice, the delivery of the executed Contract documents to the Contractor will serve as “notice to proceed.”

Pavement Structure. The combination of subbase, base course, and surface course placed on a subgrade to support and distribute the traffic load to the roadbed.

Plans. The Contract drawings showing location, character, and dimensions of the prescribed work including layouts, profiles, cross sections, and other details.

Prequalified Bidder. A Bidder who has submitted evidence satisfying the Department as to the Bidder’s qualifications based on integrity, responsibility, and competence relative to the type and size of the contemplated Projects, and has received written authorization to bid from the Department.

Prequalification Forms. The specified forms on which required information is furnished concerning the Bidder’s ability to perform and finance the work.

Prime Coat. A surface application of bitumen or other approved material to coat and bind the aggregate base.

Profile. A charted line indicating elevation grades and distances and usually depth of cut and height of fill for excavation and grading work; taken along a centerline or other designated line. A side view, as distinct from a plan or overhead view.

Project. The specific section of highway on which construction is to be performed under the Contract.

Proposal. (Commonly referred to as Bid) The Bidder’s offer on Department forms, to perform the work at the prices quoted.

Proposal Form. (Commonly referred to as Proposal) The prescribed forms on which the Department requires bids to be prepared and submitted for the work.

Proposal Guaranty. The security furnished to guarantee the Bidder will enter into the Contract if the Proposal is accepted.

Responsive Bid. A bid which meets all requirements of the “Invitation for Bids.”

Responsible Bidder. A Bidder who has met all of the Department’s prequalification requirement and actually submits a bid on a project.

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

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

Roadside. The area adjoining the outer edge of the roadway. Extensive areas between the roadways of a divided highway may also be considered roadside.

Roadway. The portion of a highway including shoulders for vehicular use.

Shop Drawings. Incidental drawings furnished by the Contractor illustrating how a specific portion of the work shall be fabricated or installed.

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

Sidewalk. A traveled pathway paralleling a highway, road, or street intended exclusively for pedestrian use.

Sieve. U.S.A. Standard Sieve, as defined in AASHTO M 92. Percent passing sieve sizes is by weight.

Special Provisions. Additions and revisions to the Standard and Supplemental Specifications covering special conditions on an individual project.

Specialty Item. Item of work that requires specialized knowledge, abilities, or equipment not ordinarily required with the major type of work specified in the Contract.

Specifications. Compilation of Special Provisions and Standard and Supplemental Specifications for performance of prescribed work.

Specified Completion Date. The date on which the Contract work is specified to be completed.

Stabilization. The modification of soils or aggregates by incorporating materials that increases load-bearing capacity, firmness, or resistance to weathering or displacement.

Standard Details. An approved set of drawings showing standard details of construction and materials.

Standard Specifications. A book of Specifications approved for general application and repetitive use.

State. The State of North Dakota acting through its authorized representative.

State Aid Project. A Project which is constructed entirely with State Funds or State and local subdivision funds.

Station. When used as a definition or term of measurement, a station is 100 linear feet.

Structures. Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, endwalls, buildings, sewers, service pipes, underdrains, foundation drains, and similar features which may be encountered in the work.

Subcontractor. An individual, or legal entity with whom the Contractor sublets part of the Contract.

Subbase. The layers of specified or selected material of designated thickness placed on a subgrade to support a base course.

Subgrade. The top surface of an embankment or cut section on a graded roadway. It is the foundation for the subbase, base, and surface course.

Substantial Completion. A Project is substantially complete when it is open for safe and convenient use by the traveling public, and all necessary safety features are in place; or, if not to be opened to traffic, when it is ready for the subsequent Project.

Substructure. All of the structure below the bearings of simple and continuous spans, skewbacks of arches and tops of footings of rigid frames, including the backwalls, wingwalls and wing protection railings.

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

Superstructure. The entire structure except the substructure.

Supplemental Agreement. A written agreement for the performance of work which is beyond the scope of the original Contract but which the Department elects to perform in conjunction with the existing Contract.

Supplemental Specifications. Approved additions and revisions to the Standard Specifications.

Surcharge. Additional fill material above the proposed grade line for the purpose of adding weight.

Surety. The legal entity or individual, other than the Contractor, executing a Proposal Guaranty.

Surface Course. One or more layers of a pavement structure designed to accommodate the traffic load; the top layer of which resists skidding and traffic abrasion. The top layer is sometimes called "Wearing Course."

Tack Coat. An application of bitumen to an existing asphalt surface to provide bond with the next course.

Titles (or Headings). The titles or headings of the Sections and Subsections in this book are for reference only and shall have no bearing on the interpretation of specifications.

Traveled Way. The portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

Unbalanced Bid. A bid that does not reflect the true cost of providing the material, equipment, and labor required to complete the item of work. (See "Materially Unbalanced Bid" and "Mathematically Unbalanced Bid.")

Variable Costs. Costs that change in relation to the activity and work being performed.

Work. The furnishing of all labor, materials, equipment, and incidentals necessary to complete the Project according to all duties and obligations imposed by the Contract.

Working Day. A calendar day on which weather and other conditions not under the Contractor's control does not prevent construction operations from proceeding with the normal working force engaged in performing the controlling item or items of work which would be in progress at that time.

Work Drawings. Supplemental design sheets or similar data which the Contractor is required to furnish such as shop drawings, product data sheets, erection plans, falsework plans, framework plans, cofferdam plans, and bending diagrams for reinforcing steel.

Work Order. A written order, signed by the Engineer, of a Contractual status requiring performance by the Contractor without negotiation.

Written Permission of the Engineer. A letter signed by the Engineer granting specific permission and outlining limitations of the permission. When these specifications indicate that work shall be "required, requested, directed, authorized, ordered, permitted, suspended, approved, accepted, or rejected," it shall be understood that these expressions and others similar to them are followed by the phrase, "by the Engineer."

SECTION 102 BIDDING REQUIREMENTS AND CONDITIONS

102.01 PREQUALIFICATION OF BIDDERS.

Only prequalified Bidders will be allowed to bid on any Project. Evidence consists of detailed information regarding the Bidder's finances, organization, equipment, and previous experience, provided on standard forms furnished by the Department. The prequalification forms shall be submitted not less than 7 days before the bid opening in which the Bidder desires to bid, and at such additional times as the Director may request or the Bidder elect. The prequalification shall be in force for the time period specified in the Department's written authorization.

The Director reserves the right to check any or all statements submitted by the Bidder, and to obtain additional pertinent information from other sources. The Department reserves the right to disqualify a prospective Bidder for any reasons stated in Section 102.13.

102.02 CONTRACTOR'S LICENSE.

A Bidder is not required to have a Contractor's license from the State of North Dakota to bid on a Project, however, a Contract will not be awarded until the Contractor obtains an appropriate North Dakota Contractor's license.

102.03 CONTENTS OF PROPOSAL FORMS.

The Proposal Form will show the location and description of the contemplated construction, the estimate of the various quantities, the types of work to be performed or materials to be furnished, and the schedule of items for which Unit Bid Prices are invited. The Proposal Form will state the time in which the work must be completed; and the date, time, and place for opening of Proposals. The Proposal form will also include

any Special Provisions or requirements which vary from or are not contained in the Standard Specifications.

All papers bound with or attached to the Proposal Form are considered a part of the Proposal and must not be detached or altered when the Proposal is submitted. The Bidder may attach a computer-printed bid schedule according to Section 102.07 C.2.

The Plans, Specifications, other documents designated in the Proposal Form will be considered a part of the Proposal whether attached or not.

The prospective Bidder shall pay the amount stated in the Notice to Contractors for each copy of the Proposal Form and each set of Plans obtained from the Department.

102.04 ISSUANCE OF PROPOSAL FORMS.

Proposal Forms will be issued in accordance with the Advertisement for Bids.

102.05 INTERPRETATION OF QUANTITIES IN BID SCHEDULE.

The quantities appearing in the bid schedule are estimates prepared for comparison of bids. Payment will be made for actual quantities of work performed and accepted or materials furnished according to the Contract. The estimated quantities of work and materials may be increased, decreased, or pay items may be eliminated in their entirety.

102.06 EXAMINATION OF PLANS, SPECIFICATIONS, SPECIAL PROVISIONS, AND SITE OF WORK.

The Bidder is to examine the site of the proposed work, the Proposal, Plans, Specifications, Supplemental Specifications, Special Provisions, and all other Contract forms before submitting a Proposal. The Bidder is responsible for all site conditions that should have been discovered with a Bidder site investigation. The submission of a proposal will be considered conclusive evidence that the Bidder is satisfied with the conditions to be encountered in performing the work and as to the requirements of the proposed Contract.

Boring logs and other records of subsurface investigations are available for inspection by Bidders. It is made available so all Bidders have access to identical subsurface information available to the Department, and is not intended as a substitute for personal investigation, interpretations, and judgment of the Bidders. This availability shall not relieve the Bidder of the responsibility stated in the preceding paragraph. The Department will not be bound by any statement or representation concerning conditions made by any of its employees or agents before the execution of the Contract, unless included in the Proposal Form, Plans, Specifications, Supplemental Specifications, Special Provisions, or related Contract forms.

Any explanation desired by a Bidder regarding the meaning or interpretation of the Proposal Form, Plans, Specifications, etc., must be requested from the Central Construction Office in adequate time to allow a reply to reach all Bidders before submission of their Bids. Interpretations will be made by addendum and will be furnished to all prospective Bidders by either certified letter, Facsimile (FAX), or other electronic transmission before the time set for opening of Bids. Oral explanations or instructions given before the bid opening will not be binding.

102.07 PREPARATION OF PROPOSALS.

- A. **General.** The Bidder shall prepare the Proposal Form furnished by the Department utilizing one of the following methods:
1. Electronic bid on the internet using Bid Express, as specified below.
 2. Electronic bid on a 3-1/2 inch computer diskette or compact disc (hereinafter diskette) with accompanying printout. The printout can be the Bidder's Proposal generated from Expedite software or the paper Proposal Form furnished by the Department.
 3. Paper bid on the Proposal Form furnished by the Department.

Any and all Department addenda to the Proposal shall be a part of the Bidder's Proposal.

The Bidder shall file with the Department a properly executed blanket bid bond, or shall submit an individual bid bond or certified check with the proposal, as specified in Section 102.09 of the Standard Specifications. To be eligible to submit electronic bids on the internet, the Bidder shall have a properly executed annual bid bond on file with the Department.

If discrepancies are found between proposals submitted by the same Bidder in different media, hand prepared paper bids shall govern over electronic printouts, electronic printouts shall govern over diskettes, and diskettes shall govern over electronic bids submitted over the internet.

The Department will provide bidding information, Plans, proposal forms, addenda and other documents on the Department's Web site. Bidders shall check the Department's Web site for addenda prior to submitting a bidders proposal. The Department will post all addenda no later than 4:00 p.m. Central Time two days before the bid opening. An exception to this timeframe is the withdrawal of a project from the bid opening. Bidders shall acknowledge the receipt of all addendums as designated in the proposal form. Electronic bid files (Expedite files) are provided through the Bid Express on-line bidding exchange at <http://www.bidx.com/> and the Department's Web site at <http://www.dot.nd.gov/>. Bidders utilizing Expedite shall ensure they have downloaded any addenda files in regards to the Expedite electronic bid files, prior to submitting their final bid. If using the Expedite bid files, bidders shall check either the Bid Express Web site or the Department's Web site after 5:00 p.m. Central Time two days before the bid opening, to ensure that all addenda files for the Expedite files have been downloaded before submitting the final bid.

Interested parties can subscribe to the Bid Express on-line bidding exchange by following the instructions provided at the www.bidx.com Web site or by contacting:

Info Tech Inc.
5700 SW 34th Street, Suite 1235
Gainesville, FL 32608-5371
email: <mailto:customer.support@bidx.com>

When an item on the Bid Schedule allows a choice of alternates, the Bidder shall indicate the choice for that particular item.

Proposals submitted by (1) an individual must be signed by that individual, (2) a partnership, must be signed by a partner, or (3) a corporation must be signed by an officer of the corporation with the officer's title. Proposals submitted by a joint venture must be signed by a legally qualified representative of each of the parties to the joint venture. A Proposal may be executed for an individual, a legal entity, or a joint venture by anyone having a power of attorney, provided a copy of the power of attorney is attached to the proposal or is previously filed with the Department.

Properly execute the Proposal. Proposal not submitted via the internet shall have the required signatures, in ink, in the space provided on the Proposal Form. If submitting a diskette with accompanying printout, the Bidder shall execute either the Department-furnished paper Proposal Form or the Expedite-generated Bidder's Proposal.

A Bidder may submit bids on more Projects than they desire to accept. Each such bid proposal must be covered by a Proposal guarantee. The Bidder may indicate the total work desired and the Director will determine which of the low bids will be accepted within the Bidder's indicated bid limitations. This limitation will apply only to Projects on which the Bid Limitation Section in the Proposal Form has been completed by the Bidder.

- B. Combination (Tied) Proposals.** Proposal Forms may be issued for Projects in combination or separately, so bids may be submitted either on the combination or on separate units of the combination. The Department reserves the right to make awards on combination bids or separate bids to the advantage of the Department. Combination bids, other than those specified, will not be considered. Separate Contracts will be written for each Project included in the combination.
- C. Electronic Bidding on the Internet.** Prior to submitting electronic bids over the Internet, the Bidder shall have a digital identification (ID) issued by the Department, on file with Info Tech Inc. and enabled by Info Tech Inc. Using this digital ID shall constitute the Bidder's signature for proper execution of the Proposal.
1. Download the EBS files, DBE bin files and any addendums from the Bid Express or Department's Web site.
 2. Use Expedite software to generate and prepare the Bidder's Proposal.
 - a. Provide a unit price for each bid item, except as not required in the case of alternate bid items. Follow the software instructions and review the help screens provided on the Bid Express Web site to assure that the schedule of items is prepared properly.
 3. Submit the bid according to the requirements of the Expedite software and the Bid Express Web site. Bidders should not submit a bid on a diskette with accompanying printout or a paper bid, when submitting Internet bids. If the bidder does submit a bid on a diskette with accompanying printout or a paper bid in addition to the internet submittal, the Department will disregard the Internet bid.

The Department will consider bids submitted over the Internet as accepted, at the time and date specified in the Notice to Bidders and not before such time and date.

D. Electronic Bidding on a Diskette With Accompanying Printout.

- 1 Download the EBS files, DBE bin files and any addendums from the Bid Express or Department's Web site.
- 2 Use Expedite software to generate and prepare the Bidder's Proposal.
 - a. Provide a unit price for each bid item, except as not required in the case of alternate bid items. Follow the software instructions and review the help screens provided on the Bid Express Web site to assure that the schedule of items is prepared properly.
3. Each diskette shall be labeled with the Bidder's name, the Department-assigned Bidder-identification code, and a list of the proposal numbers included on that diskette, as indicated in the following example:

Bidder Name
Bidder ID
Proposals: 1, 12, 14, 16, & 22

- a. If bidding on more than one proposal in the bid opening, the Bidder may include all proposals for that bid opening on one diskette. However, only submitted proposals (with no incomplete or extraneous files) may be on the diskette.

The accompanying printout shall be prepared in accordance with 102.07 E.1a.

E. Preparation of Bid Schedule.

1. **Paper Bid.** The Bidder shall enter a unit price in numerals on the Bid Schedule for each bid item, except as not required in the case of alternate bid items. The Bidder shall enter the product of each unit price and respective quantity. The sum of the products (Total Sum Bid) shall be entered where indicated.
 - a. **Computer-Printed Bid Schedule.** The Bidder may substitute a computer-printed spreadsheet bid schedule for the Bid Schedule found in the Proposal Form. The substitute schedule shall be attached to the last page of the Bid Schedule in the bound Bidder's Proposal Form.

The computer-printed bid schedule shall be a printout generated by the current version of Expedite, used by the Department.

The total sum of the bid shall be entered at the bottom of the last page of the computer-printed schedule, and entered in ink in the Total Sum Bid block on the last page of the Department's Bid Schedule.

The Bidder, or authorized representative, shall sign the substitute bid schedule in ink on the last page of the computer printout. The signer's name and title shall be printed with the signature. The person signing the schedule above shall sign and complete the Affidavit in the Proposal Form.

In case of discrepancies between item descriptions or quantities in the bid schedule in the Proposal Form and those in the computer-printed bid schedule the bid schedule in the Proposal Form will govern.

102.08 IRREGULAR PROPOSALS.

A. Proposals will be considered irregular and will be rejected if:

1. The Proposal is not properly signed and notarized; or in the case of Electronic Bidding on the Internet, the proposal is not electronically signed by use of the digital ID.
2. The Proposal is not submitted in accordance with Section 102.07 or Section 102.10.
3. The Bidder fails to provide a properly executed Proposal Guaranty.
4. The Bidder adds any provisions reserving the right to accept or reject an award, or to enter into a Contract pursuant to an award.

This does not exclude a bid limiting the maximum gross amount of awards acceptable to any one Bidder at any one bid opening. Selection of awards will be made by the Department.

B. Proposals may be considered irregular and may be rejected if:

1. The submitted Proposal fails to comply with any other requirements of the "Notice to Bidders" or the issued Proposal itself.
2. There are unauthorized additions, conditional or alternate bids, or irregularities of any kind which may make the Proposal's meaning incomplete, indefinite, or ambiguous.
3. A price per unit cannot be determined from the bid proposal, except in the case of authorized alternate pay items.
4. The Proposal does not include a unit price for every bid item, except in the case of authorized alternate pay items.
5. It is determined that any of the unit prices are materially unbalanced to the potential detriment of the Department.
6. The Unit Prices are not typed or entered in ink.
7. The check code printed on the bottom of the printout of the Expedite-generated schedule of items is not the same on each page.
8. The check code printed on the printout of the Expedite-generated schedule of items is not the same as the check code for that proposal provided on the diskette.
9. The Bidder fails to pay the \$30 administrative fee with their paper bid, before the day and time designated on the Notice to Bidders.
10. There is non-compliance with the Disadvantage Business Enterprise (DBE) requirements.

102.09 PROPOSAL GUARANTY.

A Proposal will not be considered unless accompanied by a Proposal Guaranty in a sum equal to 10 percent of the full amount of the bid, executed by the Bidder as principal and by a Surety company authorized to do business in North Dakota or by either a certified check or a cashier's check of the Bidder on a solvent bank in a sum equal to 5 percent of the bid. If within 10 days after notice of an award, the successful Bidder fails to sign a Contract with the Department, Bidder's certified or cashier's check will be forfeited to the Department, or the Principle and the Surety will forfeit to the Department the Proposal Guaranty accompanying the bid or bids on which there is a default.

Arrangements may be made with the Department to file Proposal guaranties in advance of the bid opening.

102.10 DELIVERY OF PROPOSALS.

The Bidder shall submit the Proposal Form furnished by the Department (including any and all addenda), before the time and date designated in the Notice to Bidders. The following three formats are acceptable means of submitting the Proposal Form:

- A. Electronic bid on the internet using Bid Express. Bidders utilizing this bid submission method shall not sign, notarize, nor return the Proposal Form as described in other sections of the Specifications.
- B. Electronic bid on a diskette with accompanying printout. The printout can be the Bidders Proposal generated from Expedite software or the paper Proposal Form furnished by the Department. As a separate submittal (not in the sealed bid envelope) and due at the same time and place as the sealed bid, the Expedite-generated schedule of item shall be submitted on a diskette.
- C. Paper bid on the Proposal Form furnished by the Department. Any paper bid submitted without a diskette shall be accompanied by a check or money order payable to "North Dakota Department of Transportation" in the amount of \$30 per Proposal.

Unless submitting an Electronic bid via the internet, Proposals shall be placed in a sealed envelope bearing the Bidder's name, and plainly marked to indicate its contents.

Proposals received after the time established for opening of Proposals will be returned unopened.

Mailed bids will be accepted, if all other bidding requirements have been met and the bids are received prior to the date and time designated on the Notice to Bidders. If a check or money order is required, as specified in Section 102.10 C, such check or money order must accompany any mailed bid.

102.11 WITHDRAWAL OR REVISION OF PROPOSALS.

A Bidder may withdraw or revise a Proposal after delivery to the Department, provided the request for withdrawal or revision is received in writing before the time established for opening Proposals.

102.12 PUBLIC OPENING OF PROPOSALS.

Proposals will be publicly opened and announced at the time and place indicated in the Notice to Bidders.

102.13 DISQUALIFICATION OF BIDDERS.

The Department has the right to disqualify a Bidder after a proposal has been submitted.

- A. The following reasons will be considered sufficient for disqualifying a Bidder and rejecting a Proposal or Proposals.
1. Not prequalified in accordance with Section 102.01.
 2. Evidence of collusion among Bidders. Participants in collusion will not receive recognition as Bidders for future work with the Department until they are reinstated as a qualified Bidder.
 3. More than one Proposal for the same work from an individual, firm, or corporation under the same or different name.
 4. Any other reason deemed proper by the Department.
- B. The following reasons may be considered sufficient for disqualifying a Bidder and rejecting a Proposal or Proposals.
1. Uncompleted work which the Department determines might hinder or prevent prompt completion of additional work.
 2. Failure to promptly pay or satisfactorily settle all claims for labor and material on any Contract, including those Contracts where the Contractor is a party to a joint venture that has failed to settle such claims.
 3. Default under previous Contracts.
 4. Failure to repay monies due the Department resulting from overpayments.
 5. Unsatisfactory performance on previous work or current Contract(s), consisting of, but not limited to, repeated:
 - a. Noncompliance with Contract requirements, or Engineer's directives.
 - b. Failure to complete work on time.
 - c. Instances of substantial corrective work prior to acceptance.
 - d. Instances of completed work that requires acceptance at reduced pay.
 - e. Production of non-specification work or materials.
 6. Questionable moral integrity, as determined by the Attorney General of the State, or the Department.

7. Disbarment from performing work on Federal Contracts.

SECTION 103 AWARD AND EXECUTION OF CONTRACT

103.01 CONSIDERATION OF PROPOSALS.

After the Proposals are opened and announced, each Bidder's multiplication and addition will be verified or corrected. In case of a discrepancy between a unit bid price and the extension, the unit bid price shall govern, unless the intent of the bid is obvious. The Proposals will be compared on the basis of the correct totals, and the results of such comparison promptly made public. The Department reserves the right to reject any and all Proposals, to waive technicalities, or to advertise for new Proposals.

A Bidder who wishes to claim error after the bids have been publicly opened and announced shall promptly notify the Department that an error occurred. The Bidder shall submit a notarized affidavit or declaration, under penalty of perjury, signed by the Bidder and accompanied by the work sheets used in the preparation of the bid, requesting relief from forfeiture of the bid bond and the responsibilities of award. The affidavit or declaration shall describe the specific error(s) and certify that the work sheets are the ones used in preparing the bid.

The affidavit or declaration shall be submitted no later than 5:00 p.m. on the first business day after bid opening or the claim will not be considered. The Department will review the affidavit or declaration and the certified work sheet to determine the validity of the claimed error and if the error is of the kind for which the law allows relief from forfeiture of the Proposal Guaranty. If the Department concurs in the claim of error and determines that the error is of the kind which allows relief from forfeiture, the Bidder will be relieved of responsibility and the Proposal Guaranty of the Bidder will be returned. If the Department does not concur in the error or determines that the error is not the kind for which the law allows relief, the Department may award the Contract and if the Bidder refuses to execute the Contract, the Bidder's Proposal Guaranty shall be forfeited as required by Section 103.07.

103.02 AWARD OF CONTRACT.

The award of the Contract, if made, will be to the lowest responsible Bidder whose Proposal complies with the requirements specified. The award will be made within 30 days after opening the Proposals unless an extension of this limit is agreed to in writing by both parties. If the Federal Government, other State agency, county, city, or other participating party pays any or all costs of Project construction, any award made shall not be final until concurrence has been received from the participating parties.

The successful Bidder shall submit a schedule of proposed progress as specified in Section 108.01 B. The time schedule submitted on the proposed progress chart shall not change the Contract requirements listed in the Proposal Form.

Contract award is subject to the license requirements referenced in subsection 102.02. A foreign corporation must have a certificate of authority to do business in North Dakota before a Contract can be awarded.

103.03 CANCELLATION OF AWARD.

The Department reserves the right to cancel the award of any Contract before execution without liability.

103.04 RETURN OF PROPOSAL GUARANTY.

All Proposal Guaranties, except in cases of default and those of the Bidders submitting the three lowest bids, will be returned after Proposals have been compared. The Proposal Guaranty of the Bidder submitting the lowest bid may be cashed and the money retained until the Contract has been awarded and properly executed. The Proposal Guaranties of the remaining two Bidders will be returned after the Contract is executed.

All Proposal Guaranties, except in case of defaults, will be returned upon request within a reasonable time and as provided by law.

103.05 REQUIREMENT OF CONTRACT BOND.

- A. **General.** Upon execution of the Contract, the successful Bidder shall furnish a Contract Bond on the form furnished in an amount equal to 100 percent of the Contract, issued by a responsible Surety, and approved by the Director. If the Surety Bond is voided or is no longer in force, the Contractor shall obtain another Contract Bond of an amount equal to the original.
- B. **Measurement and Payment.** The cost of the Contract Bond is included as a separate bid item in the Proposal. After the Contract is signed, payment for the item "Contract Bond" will be made as follows:
1. A written request for payment of Contract Bond items shall be submitted to the Department's district office supervising the work. If the work is on the county highway system, the request for payment shall be submitted to the County Engineer or the county's Consultant Engineer. The request for payment shall be accompanied by a receipted invoice from the bonding firm showing the Contract Bond cost and the date payment was made by the Contractor.
 2. An estimate, subject to retainage as provided in Section 109.05, will be processed to provide a lump sum payment equal to the Contract Bid Price or the actual cost indicated by the bonding firm's invoice, whichever is less. If the price bid for the item "Contract Bond" exceeds the cost indicated by the invoice, the remaining amount will be paid on the final estimate.

103.06 EXECUTION AND APPROVAL OF CONTRACT.

The signed Contract and Contract Bond shall be returned to the Department within 10 calendar days after the date of notice of Contract award. No Contract will be considered binding until execution by all parties to the Contract.

103.07 FAILURE TO EXECUTE CONTRACT.

Failure by the successful Bidder to execute a Contract and file a satisfactory Contract Bond will be considered cause for annulment of the award and forfeiture of the Proposal Guaranty to the Department. Award may then be made to the next lowest responsible Bidder, or the work may be readvertised.

103.08 ESCROW OF BID DOCUMENTATION.

- A. **General.** When specified, the Contractor shall submit a legible copy of the documentation used to prepare the bid for this Contract. The bid documentation shall be placed in escrow with a banking institution or other bonded document storage facility and preserved by that institution/facility as specified in this section.
- B. **Affidavit.** In addition to the bid, escrow bid documentation, the Bidder shall submit an affidavit, signed under oath by the Bidder or a representative of the Bidder authorized to execute Bid Proposals listing each bid document submitted by author, date, nature, and subject matter. The affidavit shall attest that the signer has personally examined the bid documentation, that such documentation is listed in the affidavit, and all bid documentation is included in the submission to the Department.
- C. **Submittal and Return of Bid Documentation.** The apparent low Bidder shall submit the affidavit and the original bid documentation in a sealed container to the Department within 5 working days after the bid opening. The container shall be clearly marked "Bid Documentation" and shall show on the face of the container the Bidder's name and address, date of submittal, Project Number, and Contract Number.

If the proposal of the apparent low Bidder is rejected by the Department, the bid documentation, if already submitted, will be returned; and the next low responsive Bidder will be notified to submit its affidavit and bid documentation. The Bidder will be allowed five working days after date of notification by the Department to submit the required documents. If this Proposal and subsequent ones are also rejected, the above procedures will continue until a Bidder's Proposal is accepted by the Department.

- D. **Duration and Use.** After award, the Department and the Contractor will jointly deliver the sealed container and affidavit to a banking institution or other bonded document storage facility selected by the Contractor and approved by the Department for placement in a safety deposit box, vault, or other secure accommodation. The document storage facility shall be located in Bismarck, North Dakota, unless otherwise approved by the Department. The Contractor will provide escrow instructions to the document storage facility consistent with this section.

The agreement with the document depository will reflect that the bid documentation and affidavit will remain in escrow during the life of the Contract or until the Department is notified of the Contractor's intention to file a claim for extra compensation according to Section 104.06 or to initiate litigation or arbitration against the Department related to the Contract. Notification of the Contractor's intention to file a claim, or initiation of litigation or arbitration against the Department, will be sufficient grounds for the Department to obtain the release and cus-

tody of the bid documentation. If such action has not been initiated, and the required statutory time to file a Contract claim has elapsed since the submission of the final estimate the document depository will be instructed to release the sealed container to the Contractor.

In accordance with the affidavit attesting that the sealed container placed in escrow contains all of the materials relied upon to prepare the bid, the Contractor agrees to waive its right to use any bid documentation other than that placed in escrow in any claim or litigation arising out of this Contract.

- E. **Refusal or Failure to Provide Bid Documentation.** Failure to provide the bid documentation shall render the bid non-responsive.
- F. **Confidentiality of Bid Documentation.** The bid documentation and affidavit in escrow are, and shall remain, the property of the Contractor. The Department has no interest in, or right to, the bid documentation unless notification of the intention to file claim is received or litigation ensues between the Department and Contractor. In the event of such notification or litigation, the bid documentation and affidavit will become the property of the Department; provided that these materials, and all copies made by the Department, are returned to the Contractor at the conclusion of litigation, or final resolution of all outstanding claims, upon execution of a final release.
- G. **Payment.** The cost of placing the bid documentation into escrow is included as a separate bid item in the Contract. After the bid documentation has been deposited in a storage facility and the Contract has been signed, payment for the entire lump sum item, "Escrow of Bid Documentation" will be made to the Contractor on the first estimate prepared after the documents have been placed in escrow. The Contractor shall be responsible for the payment of the depository rent.

These payments will be full compensation for all data compilation, container, storage rental, and any other associated costs; and no other payments will be made to the Contractor for this bid item.

SECTION 104 SCOPE OF WORK

104.01 INTENT OF CONTRACT.

The Contractor shall furnish all resources required to complete the work and shall execute the work according to the terms of the Contract.

104.02 SUBLETTING OF CONTRACT.

The Contractor shall not sublet, sell, transfer, assign, or dispose of any portion of the Contract or Contracts without written consent of the Engineer. The maximum

percentage that can be sublet shall be 70 percent of the Total Contract Amount, excluding any designated specialty items of work. The amount of any specialty items performed shall be deducted from the total original Contract Amount before computing the percentage of work sublet.

The Contracting Agency will not consider off-site commercial production of materials and manufactured component products that the Contractor purchases or their transportation to the project as Subcontracted work.

When a project contains a Disadvantaged Business Enterprise (DBE) Goal, a subContract is required with any DBE firms used to meet the goal; unless the DBE firm is classified as an oil hauler, supplier, broker, vendor, regular dealer or manufacturer.

Requests for permission to sublet shall be submitted to the District Engineer in whose District the Project is located. The request shall be in writing on Department forms accompanied by evidence showing that the organization performing the work is experienced and equipped for such work. Subcontract work shall not begin until the "Request to Sublet" is approved. The "Request to Sublet" must show the total price Subcontracted. The items of work, and quantities of each item Subcontracted shall be shown. Partial items shall be explained in detail and show the amount of each Contract item being Subcontracted.

The Contractor shall provide a copy of the Subcontract agreement or lower tier Subcontract agreements along with the "Request to Sublet." The Engineer's consent shall in no way be construed to be an endorsement of the Subcontract, the Subcontractor, or the Subcontractor's ability to complete the work in a satisfactory manner.

The Subcontract, transfer of Contract or approval of the "Request to Sublet" shall not relieve the Contractor of any responsibility to carry out the Contract; relieve the Contractor of any obligations or liability under the Contract and the Contractor's bond; create a Contractual relationship between the Contracting Agency and the Subcontractor; or convey to the Subcontractor any rights against the Contracting Agency.

The Contractor shall assure that the Subcontractor has received the following provisions:

- A. EEO Affirmative Action Requirements.
- B. Labor Rates form, U.S. Department of Labor.
- C. Required Contractor Provisions all Federal Aid Construction Contracts (FHWA-1273) and any addendums attached thereto.
- D. Other federal aid provisions such as Buy America clauses.

104.03 ALTERATION AND CHANGE OF PLANS OR CHARACTER OF WORK.

The Engineer reserves the right to make, in writing, at any time during the work, such changes in quantities and such alterations in the work as necessary to satisfactorily complete the project. Such changes in quantities and alterations shall not invalidate the Contract nor release the surety, and the Contractor agrees to perform the work as altered. A Change Order will be executed to cover changes within the scope of the Con-

tract. If the directed changes require additional time to complete the Contract, adjustments in Contract time will be made under Section 108.04.

The Contractor shall perform any extra work at unit bid prices except as provided elsewhere in this Section. When the Contract does not contain unit bid prices for the extra work and the extra work is not covered by the Contract price schedule for miscellaneous items (PS-1), the Engineer and the Contractor shall either agree to a negotiated unit price for the work or complete the work under Force Account as specified in 109.04. When requested by the Engineer to prepare a unit price for extra work, the Contractor shall provide a breakdown of labor, equipment and materials of the unit bid price.

When extra work is performed solely by a Subcontractor at a negotiated unit price, reimbursement to the Contractor for overhead and profit will be in accordance with the following:

Value of Extra Work by Subcontractor	Contractor Reimbursement for Overhead and Profit
To \$15,000	10%
Over \$15,000	\$1,500 + 5% of excess over \$15,000

No additional Contractor reimbursement is allowed for work of a Subcontractor under contract by a Subcontractor. Extra work completed by a Subcontractor at existing unit bid prices is not eligible for additional Contractor reimbursement.

- A. **Significant Changes in the Character of Work.** If the alterations or changes in quantities significantly change the character of the work under the Contract, whether or not changed by any such different quantities or alterations, an adjustment, excluding loss of anticipated profits, will be made to the Contract. The basis for the adjustment shall be agreed upon prior to the performance of the work. If a basis cannot be agreed upon, then an adjustment will be made either for or against the Contractor in such amount the Engineer may determine to be fair and equitable. If the adjustment is not acceptable to the Contractor, the Engineer will make a determination based on Section 104.03.

If the alterations or changes in quantities do not significantly change the character of the work to be performed under the Contract, the altered work will be paid for as provided elsewhere in the Contract.

The term “significant change” shall be construed to apply only to the following circumstances:

1. When the character of the work as altered differs materially in kind or nature from that involved or included in the original proposed construction, or
2. When a major item of work, as defined in Section 104.03 B, is increased in excess of 125 percent or decreased below 75 percent of the original Contract quantity.

- B. **Increased or Decreased Quantities.** Adjustments in unit prices for increased or decreased quantities will be governed by the following:

A major item of work is defined as any Contract item having a value in excess of 5 percent of the total original Contract amount. All other items are minor items. Any adjustment to Contract Unit Prices for an increase in quantity shall apply only to that portion in excess of 125 percent of original Contract item quantity, or in case of a decrease below 75 percent, to the actual amount of work performed.

1. If the quantity of any major item of work required to complete the Project increases or decreases from the original Contract quantity by 25 percent or less, payment will be made at the Contract Unit Price.
2. Should the original Contract quantity of one or more major items of work be increased or decreased by more than 25 percent, either party to the Contract may demand that a supplemental agreement be negotiated with an adjustment of unit prices satisfactory to both parties. Adequate evidence shall be submitted to support the request for Contract Unit Price adjustments. Failure to submit the bid documents will be considered as a waiver by the Contractor of the right to recover any additional costs.

An adjusted unit price for the quantity of the item which is in excess of 125 percent of the original Contract quantity will be negotiated on the basis of the actual cost of that portion of the item in excess of 125 percent, plus a reasonable allowance for profit and applicable overhead.

An adjustment to the unit price for the quantity of the item which is less than 75 percent of the original Contract quantity will be considered if the Contractor can prove, to the satisfaction of the Engineer, that the fixed expenses have not been recovered because of the decreased quantity of the item. However, total payment for the item shall not exceed that amount which would be made for 75 percent of the original Contract item at the Contract Unit Price.

The Contractor shall provide written notice of intent to request an adjustment to the bid price for underrun or overrun quantities. This notice shall be submitted as per Section 104.06 A as soon as the Contractor is aware that an overrun or underrun will occur that will require a price adjustment. This request for adjustment of the bid price of underrun and overrun quantities shall also be governed by the requirements of Section 104.06 B.

3. If aggregate production equipment has been moved off the Project and there is an increase in the quantity of aggregate, the Department will pay for remobilization. If the equipment is still on the Project and the Department has notified the Contractor of the increase in writing, no additional mobilization payment will be made.
 4. A minor item will be paid for at the Contract Unit Price for the quantity required to complete the work except when the quantity is increased to the extent that the minor item becomes a major item. Unit price adjustment will then be according to the Specifications for adjustment of major items as described herein.
- C. **Eliminated Items.** If any items in the Contract are found unnecessary for proper completion of the work, the Engineer may, upon written order to the Contractor, eliminate such items from the Contract. When items are eliminated, reimburse-

ment will be based on actual work done and all costs incurred, including mobilization before notification. If the Contractor requests an adjustment above and beyond payment at bid price for work done on the item eliminated, written notice shall be provided as per Section 104.06 A. The Contractor's request for extra compensation shall include the items required in Section 104.06 B.

104.04 DIFFERING SITE CONDITIONS.

During the progress of the work, if subsurface or latent physical conditions at the site which differ materially from those indicated in the Contract; or if unknown physical conditions of an unusual nature which differ materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the Contract are encountered at the site, the party discovering such conditions shall promptly notify the other party in writing of the specific differing conditions before they are disturbed and before the affected work is performed.

Upon written notification, the Engineer will investigate the conditions, and if he/she determines that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any work under the Contract, an adjustment, excluding loss of anticipated profits, will be made and the Contract modified in writing accordingly. The Engineer will notify the Contractor of his/her determination whether or not an adjustment of the Contract is warranted.

No Contract adjustment which results in a benefit to the Contractor will be allowed unless the Contractor has provided the required written notice.

There will be no Contract adjustment allowed on work not affected by the changed conditions.

Written notice of intent to file a claim, followed by the claim for extra compensation for differing site conditions shall be as outlined in Section 104.06.

104.05 ADDITIONAL COMPENSATION FOR SUSPENSION OR DELAY OF WORK.

If the performance of all or any portion of the work is suspended or delayed by the Engineer in writing for an unreasonable period of time (not originally anticipated, customary, or inherent to the construction industry) and the Contractor believes that additional compensation and/or Contract time is due as a result of such suspension or delay, the Contractor shall submit to the Engineer in writing a request for adjustment within seven calendar days of receipt of the notice to resume work. The request shall set forth the reasons and support for such adjustment.

Upon receipt, the Engineer will evaluate the Contractor's request. If the Engineer agrees that the cost and/or time required for the performance of the Contract has increased as a result of such suspension and the suspension was caused by conditions beyond the control of and not the fault of the Contractor, its suppliers, or Subcontractors at any approved tier, and not caused by weather, the Engineer will make an adjustment (excluding profit) and modify the Contract in writing accordingly. The Engineer will notify the Contractor of his/her determination whether or not an adjustment of the Contract is warranted.

No Contract adjustment will be allowed unless the Contractor has submitted the request for adjustment within the time prescribed.

No Contract adjustment will be allowed under this section to the extent that performance would have been suspended or delayed by any other cause, or for which an adjustment is provided for or excluded under any other term or condition of this Contract.

The Contractor's written notice of intent to file a claim, followed by the claim for extra compensation for suspension or delay of work shall be as per the requirements outlined in Section 104.06, except that the required notice time frame will be as specified in this Section.

104.06 CLAIM FOR EXTRA COMPENSATION.

- A. **Notice of Intent to File a Claim.** If the Contractor contends that additional compensation is due for work or material not clearly covered in the Contract, the Contractor shall promptly notify the Engineer in writing of the intention to file a claim and the basis for additional compensation before beginning or continuing construction on the affected work. If the basis for the claim does not become apparent until after proceeding with the work and it is not feasible to stop the work, the Contractor shall immediately notify the Engineer that work is continuing and that written notification of the intent to file a claim will be submitted within ten calendar days. The failure to give the required notification or to provide the Engineer proper facilities and assistance in keeping strict account of actual costs will constitute a waiver of the claim for additional compensation in connection with the work already performed. Notification of a claim, and the fact that the Engineer has kept account of the costs involved, shall not be construed as proving or substantiating the claim's validity.

Notice must be provided on the Department form entitled "Notice of Intent to File a Claim."

The Contractor shall mail the original notice to the Project Engineer and a copy to the Construction Engineer.

The Contractor shall define each basis for which additional compensation will be sought. Failure to properly supply all of the information required on the form entitled "Notice of Intent to File a Claim" shall constitute a waiver of the right to recover additional compensation for claim items not identified.

- B. **Submission of the Claim.** All claims shall be submitted in writing not later than 90 days after the final estimate has been submitted to the Contractor, as outlined in Title 24 of the North Dakota Century Code.

If the Contractor signs the final payment statement and certifies that the quantities are a true and correct statement of the work performed, the Contractor, by this action, accepts the amount stated as full and final payment on the Contract for the stated Project and waives all rights to any additional payments to complete the Project.

The claim submittal must describe and detail all claim items being submitted for review as described in the notice of intent to file a claim in 104.06 A. Section 109.04 shall not be used for costing of claims submitted. The description and detail in the claim submittal shall, at a minimum include:

1. A detailed narrative justification citing the basis for the claim with reference to relative portions of the Plans, Specifications, or other Contract documents.

2. A detailed explanation of the amount of extra compensation claimed is required for each item. Total Project cost claims will not be allowed as part of the claim submitted. Allowable costs submitted for each of the individual claim items will be verified using generally accepted Contract cost principles and procedures. The only costs which will be allowed will be as follows:

- a. Materials purchased as verified by copies of paid invoices.
- b. Direct payroll as verified by copies of certified payrolls.
- c. Owners share of payroll additives with each employee's applicable "ceilings" accounted for on the claim item and verified by applicable accounting records.
- d. **Equipment.** No allowance will be made for equipment replacement or replacement escalators, cost of facilities capital, interest, or any other additives not listed. All equipment hours will be paid for as straight time. The only equipment payments that will be made are as follows:

- (1) **Owned Equipment.** Payment for the actual hours of Contractor-owned equipment will be 70 percent of the base rate as determined using the procedures outlined in the then current edition of the Department manual entitled *Rental Rates for Equipment and Traffic Control Devices*.

The computed hourly equipment cost times the number of hours claimed shall not exceed the Contractor's actual purchase price for the piece of equipment being claimed.

Subcontractor-owned equipment will be paid for in the same manner as Contractor-owned equipment unless such equipment has been rented, leased, or hired by the Contractor, as provided for in (2) below.

- (2) **Leased, Rented, or Hired Equipment.** Payment for leased, rented, or hired equipment shall be the actual invoice payment plus sales tax as verified by paid invoices signed by the lessor, or by checks issued by the Contractor. If the lease or rental is weekly, the weekly rate shall be divided by 40 to get an hourly equipment cost for the claim. If the lease or rental is monthly, the monthly rate shall be divided by 176 to get an hourly equipment cost for the claim.

The computed hourly equipment cost, for each individual piece of equipment, times the number of hours claimed shall not exceed the Contractor's actual lease or rental cost for the time frame claimed.

- (3) **Operating Costs.** Equipment operating costs will be the equipment service charges as determined using the procedures outlined in the then current edition of the Department manual entitled *Rental Rates for Equipment and Traffic Control Devices*.
- (4) **Idle Time.** The number of hours of equipment use to be paid for will only be the hours that the equipment is operating on the claim item.

No payment will be made for equipment on standby unless the standby is directed in writing by the Engineer, or the standby is proven to be as the direct result of the Department's actions or inactions. Standby will be paid at 50 percent of the hourly bare rate calculated by dividing the monthly rate by 176. The listed weekly, daily, or hourly rates will not be used. Operating costs will not be paid for hours of idle time.

Payment for standby time will not be made on any day the equipment operates for eight or more hours. For equipment accumulating less than eight hours operating time on any normal work day, standby payment will be limited to only that number of hours which, when added to the operating time for that day equals eight hours. Standby payment will not be made in any case on days not normally a work day.

- e. Complete payment for overhead shall be 10 percent and profit shall be 10 percent applied to the total of (a) through (c) in Section 104.06 B.2. Superintendents and their associated costs will be covered by the 10 percent overhead item.

- 3. A statement containing the following language shall also be submitted with the claim:

Under the penalty of law for perjury or falsification, the undersigned,

 NAME TITLE

 COMPANY

of _____, hereby certifies

that the claim for extra compensation and time, if any, made herein for work on this Contract is a true statement of the actual costs incurred and time sought, and is fully documented and supported under the Contract by

I hereby agree that the Department or its authorized representative shall have the right to examine and copy all Contractor records, documents, work sheets, payrolls, invoices, depreciation schedules, and other data which are pertinent to the justification of the claim and to the substantiation of all costs related to the claim.

Date _____ /s/ _____

Subscribed and sworn before me this ____ day of _____, 20____.

 NOTARY PUBLIC
 My Commission Expires _____

- 4. The Contractor hereby agrees that the Department or its authorized representative shall have the right to examine and copy all Contractor records, docu-

ments, work sheets, payrolls, invoices, depreciation schedules, and other data which are pertinent to the justification of the claim and to the substantiation of all costs related to the claim. If the bid documents used in preparation of the bid are not being held in escrow, the Contractor shall submit the bid documentation with the claim.

Failure of the Contractor to adhere to all of the requirements outlined in Section 104.06 shall serve as a waiver of claim for additional compensation for each of the claim items submitted.

- C. **Department's Response to Claim.** After receipt of a properly submitted claim, written notification will be given to the Contractor indicating approval, partial approval, or disapproval of the claim for additional compensation as per Title 24 of the North Dakota Century Code.
- D. **Conditions Precedent to Contractor's Demand for Arbitration.** Full compliance by the Contractor with Section 104.06 is a Contractual condition precedent to the Contractor's right to demand arbitration.

No right shall exist to demand arbitration against the Department until the conditions specified in Section 104 and in Title 24 of the North Dakota Century Code have been complied with.

104.07 CLAIMS AGAINST CONTRACTOR

The Contractor will be notified in writing when construction-related claims are being assessed against the Contractor. Claims in this category include, but are not limited to: (1) unpaid royalty for material removed from Department-optioned pits and borrow areas; (2) materials, supplies, and services obtained from the Department; (3) products and materials not meeting Specifications; and (4) judgments entered against the Contractor.

If the claim is not paid within 30 days after written notification, the amount of the claim shall be withheld from any Contract payments due, except that judgments against the Contractor by a court will be immediately assessed.

It is not necessary that the claim and the withheld payment be related to the same Project or to each other.

104.08 VALUE ENGINEERING INCENTIVE.

- A. Value engineering incentive applies to cost reduction proposals initiated and developed by the Contractor for changing the drawings, designs, Specifications, or other requirements of the Contract. It does not apply to any proposal unless it is identified by the Contractor at the time of submission to the Department as a value engineering incentive proposal.
- B. The cost reduction proposals contemplated are those that:
1. Would require a Change Order to the Contract on Department forms; and
 2. Would result in savings to the Department by providing less costly items or methods than those specified in the Contract without impairing essential

functions and characteristics of the Project, such as service life, reliability, economy of operation, ease of maintenance, and necessary standardized features.

3. Any savings realized, due to the use of an aggregate source other than that designated by the Department, will not be considered a value engineering incentive. This will not prevent the Contractor from using their own aggregate source. Any savings realized in reduction of bitumen content due to switching of aggregate source shall not be allowable under value engineering incentive.
 4. The substitution of one bid item for another bid item, resulting in a decrease in the Contract amount, will not be considered as a saving under value engineering incentive. When any change involves the increase of one bid item and the decrease of another bid item, a Change Order will be executed.
 5. A cost reduction proposal will not be approved that would revise or modify work requirements or materials that are incorporated in the Contract for compliance with established Department Policies and Standards. This would not apply to other design or material features of the work which have been selected for the needs of the work.
- C. Cost reduction proposals shall be processed in the same manner as any proposal which would require a Change Order. As a minimum the following information shall be submitted with each proposal:
1. A statement that the proposal is submitted as a value engineering proposal.
 2. A description of the proposal.
 3. An itemization of the Contract requirements that requires a change and a recommendation of how to make each change.
 4. An estimate of the savings that will result from adoption of the proposal.
 5. A prediction of any effects the proposed change will have on other costs.
 6. A statement of the time the Change Order must be issued to obtain maximum cost reduction during the remainder of the Contract, and the reason for the time schedule.
 7. The dates of any previous submissions of the proposals, including Contract numbers and the Department's actions.
 8. A statement of the proposal's effect on the time for Project completion.
- D. The Department will not be liable for any delay in acting upon any proposal submitted. The Engineer's decision to accept any such proposal will be final and will not be subject to Section 104.06. The Engineer may accept, in whole or in part, any cost reduction proposal submitted by issuing a Change Order.
- E. If a cost reduction proposal is accepted, the Contractor and the Department shall share equally in any savings realized. This acceptance will be made according to this Specification or other applicable Contract provisions.

The Change Order will indicate the changes and accompanying revised costs as proposed by the Contractor and accepted by the Department. The Change Order will also reflect the estimated net savings to the Department after the estimated implementation costs and additional administrative costs incurred as a result of this proposal have been deducted.

Payment to the Contractor, in addition to the agreed upon revised costs, will be 50 percent of the net savings as determined above.

If the proposal results in an increase in cost, this Specification shall not apply. Any increase in costs above the original design shall be at the Contractor's expense.

- F. The Contractor may restrict the Department's right to use or disclose information submitted with a value engineering proposal if the proposal is rejected. Such restriction must be in writing and be submitted with the proposal. If the proposal is accepted, this restriction shall be void and the Department may use, duplicate, or disclose in whole or in part any data necessary to utilize the proposal.

SECTION 105 CONTROL OF WORK

105.01 GENERAL.

The Contractor shall be responsible for the direct supervision of the workers and their methods of workmanship.

The Department decisions will be final on all questions regarding the quality and acceptability of materials furnished, work performed, rate of work progress, interpretation of the Contract, and the acceptable fulfillment of the Contract.

105.02 CONTRACTOR REQUIREMENTS.

The Contractor will be supplied with a minimum of two sets of approved Plans and Proposal Forms including Special Provisions and have one set available at the work site at all times.

The Contractor shall give the work the constant attention necessary to facilitate progress, and shall provide full cooperation with the Engineer, Inspectors, and other Contractors.

A competent Contractor superintendent capable of reading and understanding the Contract documents and experienced in the type of work required shall be present on the project site at all times, regardless of the amount of work Subcontracted. The superintendent shall be the authorized agent of the Contractor and shall have full authority to receive and execute orders or directions of the Engineer or the Department's representative without delay.

105.03 COOPERATION WITH UTILITIES.

The Contractor will notify all utilities to have all necessary adjustments or relocation within or adjacent to the limits of construction made as soon as practicable.

In order to minimize interference with traffic operations, a detailed schedule shall be agreed to prior to beginning work, between the Engineer, utility companies and the Contractor.

These utilities will be relocated or adjusted by and at the owner's expense except as otherwise provided for in the Contract.

The Contract will indicate various utility items which are to be relocated or adjusted by the utility owner, and which are to be relocated or adjusted by the Contractor.

When the Contractor is required to move or adjust public utilities which are not provided for in the Contract, payment will be made according to Section 104.03.

At points where the Contractor's operations are adjacent to properties of companies including, but not limited to, railway, telecommunications, electric, water, sewer and petroleum products, or are adjacent to other property, damage to which might result in considerable expense, loss or inconvenience, work shall not commence until the Contractor has made the arrangements necessary to protect these properties. Unless a pay item is shown on the Plans, any and all costs associated with such protections shall be incidental to the prices bid for other items.

Utilities shown on the Plans, if any, are for reference purposes only and may not constitute an exhaustive representation of all utilities within the project limits. The Contractor shall notify the North Dakota One Call System (1-800-795-0555) prior to the beginning of construction, so they may locate and mark all utilities in the project area.

Separate Plans, if any, showing relocation or adjustment work will be made available to the Contractor, upon request to the Engineer. The Contractor shall be responsible for locating Department-owned, publicly-owned and privately-owned utilities, whether on or off the One Call System. Subcutting or scarifying over utility lines may be eliminated if, in the opinion of the Engineer, a hazardous situation exists.

The Contractor shall comply with the provisions of Sections 49-23-02, 49-23-03, 49-23-04, 49-23-05, and 49-23-06 of the North Dakota Century Code in determining the location of underground utilities.

The Contractor shall cooperate with utility owners in removing and rearranging underground or overhead utility lines or facilities to minimize interruption to service and duplication of work by utility owners.

In the event utility services are interrupted as a result of accidental breakage, the Contractor shall promptly notify the proper authority and cooperate with them until service has been restored. Work undertaken around fire hydrants shall not commence until provisions for continued service have been made and approved by the local fire authority.

Damage to utilities caused by the Contractor's operations shall be corrected at the Contractor's expense. Additional compensation will not be allowed for delays, incon-

venience or damage sustained due to interference from the utility appurtenances or the operation of moving them.

The damaged facilities shall be restored to a condition similar or equal to that existing before the damage took place. If the Engineer determines that adjustment or relocation of underground facilities is necessary to accommodate construction, necessary arrangements will be made with the owner if such work is not otherwise provided for in the Contract. This does not relieve the Contractor of any liability that may arise under the provisions of the North Dakota Century Code.

105.04 COOPERATION BETWEEN CONTRACTORS.

The Department reserves the right to Contract for and perform other or additional work on or near the work covered by the Contract.

When separate Contracts are let within the limits of any one Project, the Contractor shall carry out work under this Contract in a way that will minimize interference and delays for all parties involved.

Each Contractor involved shall accept all liability, financial or otherwise, in connection with the Contract and save the Department harmless from damages or claims resulting from inconvenience, delay, or loss experienced because of the presence and operations of other Contractors working within the limits of the same Project.

The Contractor shall arrange the work and place and dispose of materials being used without interfering with the operations of other Contractors. The work shall be coordinated with the work and sequence of other Contractors.

In case of unavoidable conflicts, the Engineer will determine the sequence of operations.

105.05 COORDINATION OF PLANS, STANDARD SPECIFICATIONS, SUPPLEMENTAL SPECIFICATIONS, AND SPECIAL PROVISIONS.

The Standard Specifications, Supplemental Specifications, Plans, Special Provisions, and all supplementary documents are essential parts of the Contract, and a requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete work. In case of discrepancy, calculated dimensions will govern over scaled dimensions; Supplemental Specifications will govern over Standard Specifications; Plans will govern over Standard Specifications and Supplemental Specifications; and Special Provisions will govern over Standard Specifications, Supplemental Specifications, and Plans. Contract Provisions included in the Proposal Form shall be treated as Special Provisions and shall govern over Standard Specifications, Supplemental Specifications, and Plans. Addenda shall govern over all items.

The Contractor shall not take advantage of any error or omission in the Contract. If an error or omission is discovered, the Engineer shall be immediately notified. The Engineer will make corrections and interpretations necessary for fulfilling the intent of the Contract.

Each bid item listed in the Plans and Proposal is referenced to a Standard Specification Section number; therefore, all of the provisions of that referenced section that are ap-

plicable to the proper completion of the bid item are binding upon the Contractor. This includes the requirements found in the “General” paragraphs as well as those specific requirements that are listed thereafter.

All other sections and subsections to which references are made within the text of the specified section will govern the same as if they were a part of that specified section in which the references occur.

All of the provisions of SECTION 100—GENERAL PROVISIONS of the Standard Specifications are applicable to all Contracts and will be enforced.

105.06 CHARACTER OF WORKERS, METHODS, AND EQUIPMENT.

- A. Sufficient resources shall be employed for completing the work in the manner and time required by the Contract.
- B. Any person employed by the Contractor or by any Subcontractor who is intemperate, prejudiced, abusive, or disorderly shall be discharged at the written request of the Engineer and shall not be employed again on the work without the Engineer’s approval. Should the Contractor fail to discharge this person or persons, or fails to furnish sufficient personnel for the proper prosecution of the work, the work may be suspended by written notice until such orders are followed.
- C. When the methods and equipment to be used are specified, other methods and equipment shall not be used without authorization of the Engineer. The request shall be in writing and shall include a full description of the methods and equipment proposed and an explanation of reasons for making the change. If approval is given, the Contractor shall be responsible for producing work in conformity with Contract requirements. If the Engineer determines that the work produced does not meet Contract requirements, the Contractor shall discontinue the substitute method or equipment and complete the remaining construction with the specified methods and equipment. Deficient work shall be removed and replaced or repaired to the specified quality, by and at the Contractor’s expense. No change will be made in basis of payment for construction items involved, nor in Contract time as a result of authorizing a change in methods or equipment.
- D. Welders on Contracts concerning SECTION 616 STRUCTURAL STEEL 616 D. shall meet the criteria established in AASHTO/AWS D 1.5 Bridge Welding Code, except as noted.

Welders utilized in the completion of all NDDOT Contracts other than those falling under SECTION 616 STRUCTURAL STEEL shall meet the criteria established in “Chapter 4 Qualification, of the American Welding Society AWS D1.1:2000 Structural Welding Code - Steel or most current edition of such Code.

Contracts using Aluminum welding shall meet the criteria established in Chapter 4, Qualification of AWS D1.2 Structural Welding Code - Aluminum or the most current edition of such code.

Welders on all Department Contracts must be qualified and certified by established welding accredits as outlined in the Code and test results must be submitted to the Materials and Research Engineer two weeks prior to the welder beginning work on the project. The test results must conform to one of the example forms as

provided in AWS D1.1 and must include the welders name, social security number, date tested, certifiers name, certifiers title, firm name and test results. The cost of testing and certification shall be at the Contractor's expense.

Approval will be for one year from the date of qualification. Approval of the welder's certification may be requested for additional periods of one year, up to a maximum of 3 one-year extensions, if the welder has been actively engaged at welding in the required positions within the previous 6 months. The Department has the right to require a requalification test at any time.

105.07 CONFORMITY WITH PLANS AND SPECIFICATIONS.

All work performed and materials furnished shall conform to the lines, grades, cross sections, dimensions, and material requirements provided in the Contract.

Materials and workmanship shall be uniform in character and shall conform to the prescribed target value or tolerance range. This tolerance range is to accommodate occasional, unavoidable, and minor variations from the median zone.

If the materials or the finished product does not conform with the Contract, but work has been produced to serve the design purpose, the Engineer will determine to what extent the work will be accepted and remain in place. The Engineer will document the basis of acceptance by Contract modification which will provide for an appropriate adjustment in the Contract price for such work or materials as necessary to conform to this determination.

If there are provisions in the Contract for the acceptance of material or work that is not in full compliance with the minimum requirements stated, the use of pay adjustment factors reflecting the payment to be made for the work or materials will be included in the applicable Section of the Specification.

If the Engineer finds the materials, work performed, or the finished products do not conform with the Contract and results in an inferior or an unsatisfactory product, the work or materials shall be removed, replaced, or corrected by and at the Contractor's expense.

When the Contract contains the word or phrase "uniform", "uniformly", "in a uniform manner", or equivalent to describe a required result or procedure and no test is specified, the degree of uniformity will be that which is obtained for quality work meeting industry standards.

Unacceptable work resulting from any cause, found to exist before final acceptance of the work, shall be removed and replaced or corrected in an acceptable manner at the Contractor's expense.

Work completed without authorization beyond the limits of the Contract, or any extra work without authority will not be paid under the provisions of the Contract. This work may be ordered removed or replaced at the Contractor's expense.

If the Contractor fails to comply with any order made under the provisions of this Contract, the Engineer has the authority to have unacceptable work remedied, or removed and replaced, and unauthorized work to be removed. The cost of this work will be deducted from any monies due or to become due the Contractor.

105.08 PLANS AND WORK DRAWINGS.

- A. **General.** Plans shall show the location and details of structures, lines, grades, and typical cross sections of the roadway. When required by the Contract documents, the Plans will be supplemented by work drawings necessary to adequately control the work.
- B. **Work Drawings Submitted by the Contractor.** Work drawings, necessary to complete the work, which are supplied by the Contractor shall be submitted to the Engineer prior to the performance of the work. The drawings shall be submitted on sheets no larger than 11 inches by 17 inches unless otherwise allowed by a work item specification.

Each sheet of the work drawings submitted shall be stamped as approved by the Contractor performing the work. At a minimum, the stamp will include the signature and title of the person approving the work drawing and the date of the approval.

The Engineer will review the work drawings as indicated in the plans, proposal, specifications, or other Contract documents. Any submittal and review of work drawings by the Engineer shall not constitute approval of nor acceptance of items represented by such drawings and shall not relieve the Contractor of any responsibility under the Contract. Such responsibility includes, but is not limited to:

1. Successful completion of the work.
2. Errors, omissions, or deviations from the Contract requirements.
3. Accuracy of dimensions and details.
4. Agreement and conformity with the Contract.
5. Proper and safe design done by the Contractor.
6. Proper and safe construction of the work.

In addition to any time requirements which may be specified for a work item, the Contractor shall allow sufficient time for the Engineer to review and comment on the submittal, and the Contractor to respond to the comments, prior to performance of the work. The Contractor shall not change any requirements as shown in the Contract documents without the Engineer's written authorization. A cover letter to be included with each work drawing submittal shall include, at a minimum:

1. The Project Number.
2. The Prime Contractor name.
3. The Subcontractor name, if applicable.
4. Verification that the work drawings have been reviewed and approved by the Contractor performing the work.
5. The items of work covered in the work drawing. Each item shall be identified by the Specification, code, and description.

6. An itemized list of any deviations from the Contract documents.
7. Any other information as required by the Engineer.

The Contract price will include the cost of furnishing all required work drawings.

105.09 AUTHORITY OF THE ENGINEER.

The Engineer has the authority to suspend the work wholly or in part for: 1) the Contractor's failure to carry out Contract provisions; 2) for failure to carry out orders; 3) for periods of unsuitable weather; 4) for conditions considered unsuitable for prosecution of the work; 5) for other conditions or reasons in the public interest; or 6) for other reasons that are mutually agreed on by the parties to the Contract.

As the Department's direct representative, the Field Engineer is delegated authority for immediate charge of engineering details of the construction Project and the administrative responsibilities for the satisfactory completion of the Project. The Field Engineer has authority to reject defective material or work not meeting Contract requirements. The Field Engineer is not authorized to alter or waive provisions of the Contract unless approved by Construction Change Order.

105.10 CONSTRUCTION STAKING.

The Engineer will furnish and set construction stakes and marks establishing lines and grades, and furnish the Contractor with all necessary information relating to them. These stakes and marks shall constitute the field control for the Contractor's use in establishing other necessary controls to perform the work.

The Contractor shall preserve all stakes and marks. Construction stakes or marks that are carelessly or willfully destroyed or disturbed by the Contractor, will be replaced and the costs charged against and deducted from payments due the Contractor.

The Department will be responsible for the accuracy of lines, slopes, grades, and other engineering work performed by the Department under this Section.

Before commencing work, the Contractor shall determine the meaning of all stakes, measurements, and marks.

The Department is not responsible for delays in setting stakes unless the Engineer is provided 14 calendar days notice before beginning work on the Project; and thereafter, 48 hours notice, not including Saturday, Sunday, or Holidays, that stakes are needed.

105.11 DUTIES OF THE INSPECTOR.

Department Inspectors are authorized to inspect all work done and materials furnished. This inspection may extend to all or any part of the work and to the preparation, fabrication, or manufacture of the materials to be used. The Inspectors are not authorized to alter or waive Contract provisions, issue instructions contrary to the Contract, or act as foreman for the Contractor.

105.12 INSPECTION OF WORK.

All material, the production of material, and each part or detail of the work is subject to inspection. The Engineer shall be allowed access to all parts of the work and shall be

furnished with such information and assistance by the Contractor as required to make a complete and detailed inspection.

The Contractor shall remove or uncover portions of the work as requested by the Engineer. After examination, the work shall be restored to the standard required by the Contract. If the work is acceptable, the uncovering, removing and restoring will be paid for under Section 104.03. If the work is unacceptable, the uncovering, removing, and restoring shall be by and at the Contractor's expense.

Any work performed or materials used without inspection by an authorized Department representative may be ordered removed or uncovered and replaced at the Contractor's expense unless the Department representative failed to inspect after having been given notice that the work was to be performed.

When any unit of government, political subdivision, utility, or railroad corporation is to pay a portion of the cost of the work covered by this Contract, its respective representatives also have the right to inspect the work. This act of inspecting does not make any unit of government, political subdivision, utility, or railroad corporation a party to this Contract, and shall not interfere with the right of either party to the Contract.

105.13 ACCEPTANCE.

A. **General.** Until final written acceptance of the Project by the Engineer, the Contractor shall be responsible and shall protect the work against damage from all causes, whether arising from the execution or from the non-execution of the work. The Contractor shall rebuild, repair, restore, or replace all work that is damaged before final acceptance at no additional cost to the Department. Damage to the work due to unforeseeable causes beyond the control of and without the fault or negligence of the Contractor, including but not restricted to acts of God, or acts of the public enemy or government authority shall be restored at the Department's expense.

The Contractor shall maintain the work site, and all work performed or completed under the Contract, until the Project is accepted. This maintenance shall be as defined in Section 107.05. If the Contract involves the placement of material or the utilization of a previously constructed subgrade, base course, pavement, or structure, the Contractor shall maintain the previously constructed work during all construction operations. Cost of maintenance work during construction and before the project is accepted shall be incidental to other items of work.

The Contractor shall remedy any improperly performed maintenance within 24 hours after receipt of notice from the Department. If unsatisfactory maintenance is not remedied within 24 hours after receipt of the notice, the Department will proceed to maintain the Project. The entire cost of this maintenance will be deducted from monies due or to become due the Contractor.

During periods that work is suspended for any cause, the Contractor shall be responsible for the Project and shall prevent damage to the Project; provide for drainage; and erect any necessary temporary structures, signs, or other facilities at the Contractor's expense.

B. **Opening to Traffic.** If the traffic control plan allows sections of the road to be closed to traffic, the Engineer may order certain sections of the road opened for

traffic. Opening these sections does not constitute acceptance of the work or a waiver of any Contract provisions. On those sections opened to traffic, the cost of maintaining the roadway for traffic will be at the Department's expense and the Contractor will be compensated as provided for in Section 104.03. Any damage to the highway not attributable to public traffic shall be at the Contractor's expense according to Section 105.13 A.

The Engineer may order all or a portion of the Project open to traffic even though construction falls behind the progress schedule (submitted according to Section 103.02) in completing shoulders, drainage structures, or other features of the work. The Contractor shall not be relieved of liability and responsibility for maintaining the roadway during the period the work is opened before final acceptance. The remaining construction operations shall be conducted with minimum interference to traffic.

- C. **Partial Acceptance.** When a unit or portion of the Project, such as a structure, an interchange, or a section of road or pavement (normally approximately five miles) is substantially complete, the Contractor may request final inspection of that unit. If the unit has been substantially completed according to the Contract, the Engineer may relieve the Contractor of further responsibility for that unit. Partial acceptance shall not void or alter any Contract terms.
- D. **Final Acceptance.** Upon receiving written notice from the Contractor of Project completion, the Engineer will make an inspection. If the Contract is found to be completed satisfactorily, that inspection will constitute the final inspection and the Contractor will be notified in writing indicating the date on which the Project was inspected and accepted.

If the inspection discloses any unsatisfactory work, the Contractor will be given the necessary instructions for correcting the work. The Contractor shall immediately comply with those instructions. Upon correction of the work, another inspection will be made which will constitute the final inspection. If the inspection discloses that the work has been satisfactorily completed, the Contractor will be notified in writing indicating the date on which the Project was inspected and accepted.

Before final acceptance, the highway, borrow pits, and all areas occupied by the Contractor in connection with the work shall be cleaned of all rubbish, excess materials, temporary structures, and equipment; and all parts of the work shall be left in condition acceptable to the Engineer.

105.14 NO WAIVER OF LEGAL RIGHTS.

Final acceptance shall not prevent the Department from correcting any measurement, estimate, or certificate made before or after completion of the work. The Department shall not be prevented from recovering from the Contractor or Surety, or both, any overpayments made on the Contract. A waiver on the part of the Department of any breach of any part of the Contract shall not be held to be a waiver of any other or subsequent breach.

The Contractor, without prejudice to the Contract terms, shall be liable for latent defects, fraud, or such gross mistakes as may amount to fraud, or as regards the Department's right under any warranty or guaranty.

105.15 FURNISHING RIGHT OF WAY.

The Department is responsible for securing Rights of Way in advance of construction. Exceptions will be indicated in the Contract.

**SECTION 106
CONTROL OF MATERIAL****106.01 GENERAL METHODS OF MATERIALS ACCEPTANCE.**

Materials shall meet the quality requirements of the Contract. Materials furnished and used in a completed item of work shall be new and unused.

Materials such as mineral aggregates, bituminous mixtures, and Portland Cement Concrete will be tested and approved as provided in the section of work under which the item is performed. For other materials a "Certificate of Compliance" shall be submitted stating that such materials or assemblies fully comply with the Contract requirements. Each lot or shipment of materials delivered to the work must be accompanied by a "Certificate of Compliance" in which the material is clearly identified. The original signed "Certificate of Compliance" shall be submitted to the Project Engineer and shall provide the following information:

- A. Project number to which the material is consigned.
- B. Name of Contractor to which the material is supplied.
- C. Kind of material supplied.
- D. Quantity of material represented by the certificate.
- E. Satisfactory means of identifying the consignment, such as Lot No., Bin No., Heat No., Factory Identification, etc.
- F. Statement that the material meets the pertinent specification required by the Contract.
- G. Signature of a person having legal authority to bind the supplier.

Progress estimates will not be issued until these requirements have been fulfilled.

Materials or assemblies used on the basis of Certificates of Compliance may be sampled and tested at any time, and if found not to be in conformity with Contract requirements will be subject to rejection whether in place or not.

In the case of small quantities of material where the value is less than \$5,000 and the material is not directly involved with the safety of the structure or roadway, the Engineer may waive the certificate requirement, and may accept the material without testing.

106.02 LOCAL MINERAL AGGREGATE SOURCES.

- A. **General.** Possible sources of local materials may be referenced and described in the Proposal. The Contractor is under no obligation to use any of these sources.

Aggregate sources controlled by the Department may only be used if referenced in the Contract. If the Contractor wishes to use a different State-controlled pit, the Contractor shall request that the Department make the pit available prior to the bid opening. These requests will be considered by the Materials and Research Engineer; if approved, all prospective bidders will be notified.

The Proposal generally shows the percentage of material passing each of several sieves, percent shale, and other items. Each of these values is derived from an analysis of the boring logs using accepted standard practices. The values are based on the samples tested from the exact locations shown. No interpretation is made or intended by the Department. Any interpretation must be based on the judgment of the person examining the information.

The water tables shown on the boring logs change with the seasons and the quantity of recoverable material may change.

It is understood that it is not feasible to determine from samples the quantity or quality of an entire deposit, and that variations shall be considered as usual and are to be expected.

The Contractor shall determine the amount of equipment, processing, blending, and all other operations required to produce specification material.

In the use of Department-owned or optioned pits, the Contractor shall fulfill all obligations imposed on the Department under the Department's options or agreements.

The pit shall be worked to conserve the available aggregate. Every effort shall be made to exhaust the portion of the pit being worked to eliminate the need to cover any unused material. All topsoil, up to a maximum depth of one foot, or as specified in the pit plat, shall be removed and stockpiled separately from the remaining stripping. After the aggregate material has been removed, the stockpiled excavated overburden and topsoil material shall be replaced within the open pit area. The topsoil shall then be uniformly distributed and smoothly graded over the entire disturbed area leaving the pit sides as flat as possible.

When the pit operation is completed and the area is restored, the pit shall be inspected by the Owner, Contractor, and the Engineer. If the pit is found acceptable, a signed standard pit release form shall be obtained from the owner.

Local governing bodies having jurisdiction may have zoning ordinances affecting removal of sand and gravel. The Contractor shall check with local authorities to obtain information on these ordinances prior to bidding a Project.

- B. **State-Optioned Deposits.** The Department may acquire an option and may assign the right to take materials from the sources described in the Proposal. The Contractor shall notify the landowner in writing that the Contractor is exercising

the Department's option to purchase materials under the terms and conditions provided in the option and any other terms and conditions which might be negotiated and agreed to between the Contractor and the landowner. The Contractor shall ensure that the agreement to acquire materials from the landowner complies with the requirements of Chapter 38-16 of the North Dakota Century Code. A copy of the written notification to exercise the Department's option, and any other agreement negotiated between the Contractor and the landowner regarding use of Department optioned pits, must be provided to the Engineer before the Contractor moves into the pit. Material (other than reject material owned by the Contractor) from Department optioned pits will only be used on Projects where the pit is referenced for use in the Proposal, unless otherwise approved by the Materials and Research Engineer in writing.

Before moving into an optioned pit, the Contractor shall contact the Engineer and the property owner or the owner's agent and inform them of the intended removal process and the proposed cartway location. An approximate date of payment for the material used shall be agreed upon by the Contractor, pit owner, and Engineer.

All material processed in the crushing or screening operation (accepted or rejected) that remains at the pit site after completion of the pit operation shall be paid for by the Contractor, to the pit owner, at the applicable royalty. The Contractor shall have 180 days, or as shown on the pit list, after completion of the pit operation to remove the processed material from the pit site. If the material is not removed within this time, ownership shall revert back to the pit owner, unless a storage fee is paid as outlined in the Department's material option agreement. If the Contractor does not wish to keep the material, the Contractor shall make arrangements with the owner to satisfactorily dispose of the material.

The royalty payment shown in the pit list for the material includes consideration for the use of a reasonable area adjacent to the pit, for stockpiling of stripping, wasting material, plant site (not to exceed eight acres), and for the use of a cartway 50 feet wide for ingress and egress to the pit.

The Engineer will determine the total amount of all processed or rejected material and the payment due the pit owner. The Contractor and the pit owner will be notified of this information in writing. Upon receipt of this information, the Contractor shall make payment to the pit owner according to the terms of the agreement.

- C. **State-Owned Deposits.** Department-owned aggregate sources will be referenced in the Proposal. Material from the Department-owned deposits will only be used on Projects where the pit is referenced for use in the Proposal, unless otherwise approved by the Materials and Research Engineer. If the Department allows the Contractor to use this material for work on other than Department Projects, a fair market royalty will be charged to the Contractor. This royalty will be determined by the Department and may be different than the royalty charged for the Project.

A royalty will be charged for all aggregate taken from the pit and incorporated into the project. The royalty will be listed in the proposal for each class of aggregate used on the project. If a class of aggregate is needed that is not listed in the proposal, the Department will determine a fair market royalty and add it to the Contract Unit Price by Change Order. All material remaining at the completion of the Project, including reject material, will be the property of the Department and shall be bu-

ried, as directed by the Engineer, at the Contractor's expense, before reclaiming the pit site.

The Contractor shall be liable for any crop damage which occurs in a Department-owned pit. Before moving into a Department-owned pit, the Contractor shall consult with the District Engineer. Department-owned pits shall be operated in a manner and left in a condition satisfactory to the District Engineer.

- D. **Privately- Owned Deposits.** Any information issued by the Department for privately-owned pits is for use by all Bidders on an equal competitive basis. Bidders shall not acquire such private pits for their exclusive use.

If material is obtained from other than Department-owned or optioned sources, the Contractor shall acquire the necessary rights to these materials and pay all related costs. All costs of exploring and developing other sources shall be at the Contractor's expense.

- E. **Aggregate Source Limitations.** Any aggregate sources within a 7-mile radius from the center of Section 16-146-96 in Dunn County, 6-mile radius from the center of Section 28-138-97 in Stark County, and 4-mile radius from the center of Section 26-134-101 in Slope County will not be used.

Any aggregate sources outside the 7-mile and within a 30-mile radius of the center of Section 16-146-96 in Dunn County, outside the 6-mile and within the 10-mile radius from the center of Section 28-138-97 in Stark County, and outside the 4-mile and within the 8-mile radius from the center of Section 26-134-101 in Slope County, and locations identified below may be used if samples are taken and tested for eronite fibers, and written approval has been received from the North Dakota Department of Health (NDDOH).

The locations are identified by the center of the section and are as follows:

Section 29-135-98, Slope County - Radius 6 miles
 Section 19-137-94, Stark County - Radius 3 miles
 Section 9-136-94, Stark and Hettinger Counties - Radius 3 miles
 Section 17-136-93, Hettinger County - Radius 3 miles
 Section 30-137-92, Hettinger County - Radius 2 miles
 Section 31-131-103, Bowman County - Radius 4 miles
 Section 20-139-91, Stark County - Radius 4 miles
 Section 28-135-91, Stark County - Radius 1 miles
 Section 12-135-95 Hettinger County - Radius 2 miles
 Section 8-139-103, Golden Valley County - Radius 2 miles
 Section 8-139-104, Golden Valley County - Radius 2 miles
 Section 18-137-102, Billings County - Radius 2 miles
 Section 29-132-98, Adams County - Radius 2 miles
 Section 23-131-97, Adams County - Radius 1 miles
 Section 2-131-90, Grant County - Radius 3 miles

Testing must be conducted according to the NDDOH guidance, which includes prior approval of a sampling plan and concurrence with the laboratory results. The guidance will be available at <http://www.ndhealth.gov/EHS/Eronite>. If all submitted documentation appears satisfactory after review, the NDDOH will provide written approval for the location. All laboratory tests must be negative for the

presence of eronite for the NDDOH to provide written approval. The NDDOH will provide written approval or denial for the location within 10 to 14 days of the submitted documentation postmarked date.

Two weeks prior to the start of any mining or processing of material in any of the previously identified locations that require NDDOH approval, the Contractor shall provide to the District Engineer and the Materials and Research Engineer a copy of the written approval obtained from the NDDOH. In addition, the Contractor will be required to clearly mark in the field, to the satisfaction of the Engineer, the area(s) that have been approved for mining and these markings will be maintained during the entire project. If at any time it is determined by the NDDOT or the NDDOH that the Contractor is outside of the approved area the Contractor's operation will be shut down and approval will need to be obtained from the NDDOH before any material can be used.

All cost for labor, material, equipment to test drill, obtain samples, and laboratory testing are the responsibility of the Contractor.

106.03 SAMPLES, TESTS, CITED SPECIFICATIONS.

All materials will be approved by the Engineer before incorporation in the work. Materials found to be unacceptable will not be paid for and shall be removed at the Contractor's expense. Tests according to cited Specifications will be made by and at the expense of the Department. All materials being used are subject to inspection, test, or rejection at any time before or during incorporation into the work. Copies of all tests will be furnished to the Contractor's representative on request.

106.04 STORAGE OF MATERIALS.

Materials shall be stored to preserve their quality and fitness for the work. Stored materials will be subject to inspection and retesting before use in the work. Stored materials shall be located to allow their prompt inspection. Approved portions of Right of Way may be used for storage purposes and for placing the Contractor's plant and equipment. Any additional space required must be provided by the Contractor. Private property shall not be used for material storage without written permission of the owner or lessee; and if requested, copies of written permission shall be furnished to the Engineer. Storage sites shall be restored to their original condition by and at the Contractor's expense, unless exceptions are specifically outlined in the written permission document.

106.05 HANDLING MATERIALS.

Materials shall be handled to preserve their quality and fitness for the work. Aggregates shall be transported in vehicles constructed to prevent loss or segregation of materials after loading and measuring.

106.06 STOCKPILING AGGREGATE AND SALVAGED MATERIALS.

Stockpile sites shall be cleared and grubbed before stockpiling material. Sites shall be firm, smooth, and well drained. A bed of aggregate shall be maintained under the stockpile to prevent contaminating of stockpiled material with soil or foreign matter.

The material shall be stockpiled to prevent segregation. Equipment or methods that cause segregation, degradation, or contamination of the aggregate shall not be used in

constructing stockpiles or delivering materials. Material with segregation or contamination shall not be incorporated into the Project.

The intermingling of aggregate from adjacent stockpiles of different types or sizes shall be prevented.

Equipment will not be permitted on salvaged bituminous material that will remain the property of the Department or that will be used for hot recycled bituminous pavement. When the Plans specify the material to be salvaged for these purposes, the material shall not be stockpiled higher than 15 feet.

106.07 RIGHTS IN AND USE OF MATERIAL FOUND IN THE WORK.

The Engineer may authorize the use of materials found in the excavation that are suitable for bid items other than excavation. The Contractor will be paid for both the excavation of the material at the corresponding Contract Unit Price and for the pay item for which the excavated material is used. The removed material shall be replaced with acceptable material at the Contractor's expense. No charge for the materials used will be made against the Contractor.

Material from within the highway Right of Way which is not within the construction limits shall not be removed without written authorization from the Engineer. If payment by the Contractor is required for material deposits found outside the construction limits on the Right of Way and used in the work, it shall be at a price agreed upon by both parties before removal commences. The Contractor shall restore the area from which the material was removed to a condition satisfactory to the Engineer.

Material from any existing structure designated for removal may be used temporarily in the erection of the new structure. Such material shall not be cut or damaged without the approval of the Engineer.

106.08 DEPARTMENT-FURNISHED MATERIAL.

Material designated to be furnished by the Department will be delivered or made available at locations specified in the Contract. The cost of handling and placing Department-furnished materials shall be included in the Contract Bid Price for the item which they are used.

The Contractor shall be responsible for materials delivered. Deductions will be made from any monies due for any shortages, deficiencies, and damage that may occur to the material after delivery. Demurrage charges, resulting from the failure to accept the material at the designated time and point of delivery will be deducted from monies due the Contractor.

106.09 BUY AMERICA PRODUCTS.

All steel or iron materials permanently incorporated into the work shall be of Domestic Origin and all manufacturing processes, including applications of coatings, must occur in the United States. For this purpose the United States is defined as any of the 50 states, the District of Columbia, Puerto Rico, and other territories and possessions of the United States of America. A coating includes all processes which protect or enhance the value of the material to which the coating is applied. The manufacturer shall

include a statement on a certification that the steel and iron products are of domestic origin.

Steel and iron products produced and manufactured outside the United States, as defined above, may be incorporated into the work if the total of these items constitute less than 0.1 percent of the total Contract cost, or \$2,500, whichever is greater.

Pig iron and processed, pelletized, and reduced iron ore produced outside the United States may be used in the domestic manufacturing process for iron and steel materials as long as all manufacturing processes for these materials, including the application of coatings, occur in the United States.

106.10 CONVICT LABOR.

Materials produced after July 1, 1991, by convict labor may only be incorporated in a federal aid highway construction project if such materials have been:

- A. Produced by convicts who are on parole, supervised release, or probation from a prison or,
- B. Produced in a qualified prison facility and the cumulative annual production amount of such materials for use in federal aid highway construction does not exceed the amount of such materials produced in such facilities for use in federal aid highway construction during the 12-month period ending July 1, 1987.

A qualified prison facility is any prison facility in which convicts, during the 12-month period ending July 1, 1987, produced materials for use in federal aid highway construction projects.

106.11 QUALIFIED LABORATORIES AND TESTING PERSONNEL.

For all projects on the National Highway System or the Interstate System, testing equipment shall meet the requirements listed in the NDDOT Qualified Laboratory Program. The testing personnel shall meet the requirements of the NDDOT Technician Certification Program (TCP). This program is administered by the Materials and Research Division and the District Materials Coordinators. All testing performed by Contractor, private testing laboratories, or consultant technicians for acceptance purposes must meet these requirements.

SECTION 107 LEGAL RELATIONS AND RESPONSIBILITIES

107.01 LAWS TO BE OBSERVED.

It is the Contractor's responsibility to keep fully informed with, and observe and comply with all of the following that, (1) affects in any manner those engaged or employed on the Project, or (2) affects the conduct of the work on the Project:

Federal and State laws; local laws and ordinances; and regulations, orders and decrees of bodies or tribunals having any jurisdiction or authority, including legal requirements governing the safety, health, sanitation, and performance of the Contract in general.

The Contractor shall protect and indemnify the Department and its representatives against any claim or liability arising from the violation of any of the above listed items, whether violated by the following companies or any employees of the following companies:

The Contractor; Subcontractor(s) at any tier; suppliers of materials or services; and any others engaged by the Contractor.

The Contractor, without cost to the Department, has the sole responsibility to provide, inspect and maintain all safeguards, safety devices, protective equipment, safety programs, and provide actions necessary to reasonably protect the life, health, and property of the Contractor, Subcontractors, the state, the public and each of the employees, officers, assigns, and agents of the Contractor, Subcontractors and the state, engaged or employed on the Project.

Any inspector of the Occupational Safety and Health Administration or other legally responsible agency involved in safety and health administration shall be provided unrestricted access to the work site.

107.02 PERMITS, LICENSES, AND TAXES.

- A. **General.** The Contractor shall obtain and submit to the Engineer all permits and licenses; pay all charges, fees, and taxes; and give all notices necessary and incidental to the due and lawful prosecution of the work.

These charges, fees, or taxes may include, but are not limited to, State sales taxes, City sales taxes, and TERO or Indian Reservation taxes or requirements.

No claim shall be made to the Department for reimbursement of these taxes, charges, fees, or for any costs related in meeting TERO or Indian Reservation requirements. All these costs shall be included in the bid prices for the Contract items.

- B. **United States Army Corps of Engineers Water Permit.** All waterways listed below will require a United States Army Corps of Engineers Water permit in addition to the North Dakota State Water Commission permit. It is the Contractor's responsibility to obtain the necessary permit from the Corps of Engineers after the Contract has been awarded. Corps of Engineers Form 4345 must be completed and submitted to the Corps by the Contractor to obtain the permit prior to obtaining water from the waterways listed:

MISSOURI RIVER - from the Montana-North Dakota state line to the North Dakota-South Dakota state line

YELLOWSTONE RIVER - from the Montana-North Dakota state line to its mouth

UPPER DES LACS LAKE

RED RIVER OF THE NORTH - from Wahpeton, ND, to the Canadian border

BOIS DE SIOUX RIVER - from the South Dakota-North Dakota state line to Wahpeton, ND

JAMES RIVER - from Jamestown, ND, to the North Dakota-South Dakota state line

For additional information from the Corps of Engineers, contact:

Bismarck Regulatory Office
1513 S. 12th St.
Bismarck, ND 58504
Telephone 701-255-0015

107.03 PATENTED DEVICES, MATERIALS, AND PROCESSES.

If any design, device, material, or process covered by letters of patent or copyright is used, their use shall be by legal agreement with the patentee or owner. The Contractor and the Surety shall indemnify and save harmless the State, any affected third party, or political subdivision from all claims for infringement resulting from use of any patented design, device, material or process, or any trademark or copyright; and shall indemnify the State for any costs, expenses, and damages which it may be obliged to pay by reason of infringement during prosecution or after completion of the work.

107.04 ENVIRONMENTAL PROTECTION AND CULTURAL RESOURCE PRESERVATION RESPONSIBILITIES.

A. Contractor-Optioned Areas.

1. **General.** At least 30 calendar days prior to using Contractor optioned material sources any ground disturbance, the Contractor shall provide the Project Engineer with a legal description completed SFN 58466 and map. The map shall include any Contractor optioned material sources (including rip-rap and material from commercial sources), and any other area of planned ground disturbing activities, such as staging area(s), plant site, stockpile area(s), and haul access road(s).

The completion of this process (Section 107.04 review process) is weather dependent and may take longer than 30 days; surveys cannot be completed during adverse weather conditions or poor ground visibility.

2. **Environmental Review Process.** The Department's Environmental Section, in cooperation with the US Fish and Wildlife Service (USFWS), will investigate the proposed material source area(s) to determine if there is a potential for threatened or endangered species, wetlands, or Department of Transportation Act Section 4(f) properties (easement wetlands, grassland easements, waterfowl production areas, wildlife management areas, or National Wildlife Refuge properties).

If environmental resources are not identified, environmental approval will be granted at that time. The Department's Cultural Resource Section will be

notified of the findings by the Environmental Section and will begin the Cultural Review Process, as identified in Section 107.04 A.3.

If the potential for environmental resources exists, the Environmental Section will coordinate with the USFWS to conduct an on-site review of the proposed material source area(s) to ensure avoidance of environmental resources. If approved, the Cultural Resource Section will be notified of the findings by the Environmental Section and will begin the Cultural Review Process, as identified in Section 107.04 A.3. If not approved, the Contractor will be notified by the Engineer.

The Department's review and subsequent approval does not relieve the Contractor of the responsibility of complying with all Federal and State laws and regulations which govern the protection of wetlands protected under the Clean Water Act and Executive Order 11990, threatened and endangered species protected under the Endangered Species Act, and Section 4(f) properties protected under Section 4(f) of the Department of Transportation Act.

3. **Cultural Review Process.** The Cultural Resource Section will investigate the proposed material source area(s) to determine what may be necessary to ensure compliance with Section 106 of the National Historic Preservation Act (NHPA). There may be a need for cultural resource investigations. These investigations typically would include a Class III cultural resource inventory of the proposed material source area(s). The Engineer will notify the Contractor if additional cultural resource work is required. After completion of all required cultural resource work, the Engineer will provide the Contractor written approval to proceed.

The Contractor is responsible for all costs associated with Section 106 (NHPA) compliance, including Class III cultural resource inventory, testing, and data recovery. The Contractor will not receive payments or compensation for delays resulting from the Department's review. Discoveries will be handled pursuant to Section 107.04.C.

If cultural resource work is recommended for a proposed material source area(s) that is located on Indian Trust (allotted) lands, an Archaeological Resources Protection Act (ARPA) permit must be obtained from the Bureau of Indian Affairs (BIA) prior to this work beginning. The Contractor must obtain written permission from the property owners and the tribe before the BIA will issue the ARPA permit. The Department will not be responsible for, nor participate in, costs that are incurred or claimed by the Contractor resulting from delays or other inconvenience encountered in obtaining the permit.

The Department's review and subsequent independent completion of the Section 106 (NHPA) process will not relieve the Contractor of the responsibility of complying with all Federal and State laws and regulations which govern the discovery of human remains and the salvage and preservation of cultural resources that are discovered during material source operations.

4. **Out-of-State Sources.** If the Contractor optioned material source is located out of state, the Contractor must provide the Engineer documentation from

the out-of-state agency showing the material source is available for use according to each state's review process. The Contractor will be notified by the Engineer of the need for any additional review prior to using the proposed material source(s) in the State of North Dakota.

B. Department-Owned or Optioned Areas.

1. **General.** All necessary clearances will be obtained prior to bidding.

C. Discoveries.

1. **Environmental Process.** When the Contractor is operating within the Right of Way, easement areas, or within Contractor optioned, or Department owned or optioned material source area(s) and encounters a threatened or endangered species at the project site, work at that location shall be temporarily discontinued. The Contractor shall report the sighting immediately to the Project Engineer and shall not resume work until the Department obtains clearance from the US Fish and Wildlife Service and approval to proceed is provided in writing from the Department.

If the Contractor fails to notify the Engineer within 24 hours of the sighting, the Contractor shall be liable for all standby costs, all damage incurred, and all costs associated with the preservation and protection of the species pursuant to the resource and regulatory agencies guidance. In addition, the Contractor is liable to the Department for any violation penalties because of the failure to comply with Federal and State laws.

2. **Cultural Process.** When the Contractor is operating within the Right of Way, easement areas, or within Contractor optioned, or Department-owned or optioned area(s) and encounters prehistoric dwelling sites, human remains, or concentrated historic or prehistoric artifacts, work at that location shall be temporarily discontinued. The Contractor shall inform the Engineer immediately of the discovery and shall protect the discovery area from further disturbance until directed otherwise by the Engineer. The Contractor shall not resume work in the vicinity of the discovery until approval to proceed is provided in writing from the Department.

If cultural resources are discovered, procedures identified in 36 CFR 800.13 will be followed. If the discovery includes human remains, the procedures in North Dakota Administrative Rule 40-02 in accordance with State Law 23-06-27, or 43 CFR Part 10 in accordance with Public Law 101601 will be followed, as applicable and defined in each.

If the Contractor fails to notify the Engineer within 24 hours of the discovery, the Contractor shall be liable for all standby costs, all damage incurred, and all costs associated with salvage and preservation activities that may result from the discovery. In addition, the Contractor is liable to the Department for any violation penalties because of the failure to comply with Federal and State laws.

D. Reporting.

1. **General.** The permittee is responsible for complying with all reporting requirements contained in the regulatory permit(s). Documentation of all

reporting pursuant to the conditions of the permit(s) shall be copied to the Engineer and Environmental Section for inclusion in the project record.

107.05 RESPONSIBILITY TO THE PUBLIC.

A. Maintaining Traffic.

1. **General.** Construction work shall be conducted to minimize obstructions to traffic. The safety and convenience of the general public and residents along the highway and the protection of persons and property shall be provided for by the Contractor.

The roadway shall be kept open to all traffic during progress of the work. Where provided in Contract, traffic may be bypassed over an approved detour route. The portion of the roadway being used by public traffic shall be kept in a condition that safely and adequately accommodates traffic. The Contractor shall also provide and maintain in a safe condition temporary approaches or crossings and intersections with trails, roads, streets, businesses, parking lots, residences, garages, and farms. Details on location of access points and construction procedures shall be worked out with the Engineer in the field prior to the start of the project. The cost of maintaining traffic over the section of road undergoing improvement shall be at the Contractor's expense. Snow removal will not be required of the Contractor to maintain public traffic.

The Contractor shall furnish, erect, and maintain all necessary barricades, warning signs, lights, and traffic control devices to protect the work and safety of the public and the workers.

All traffic control, pilot cars, and flagging shall meet Section 704 and the traffic control plans. The cost of maintaining and protecting traffic will be considered incidental to the price bid for other Contract items when no separate pay item for "Traffic Control" is provided.

The cost of flagging will be paid for as provided in Price Schedule PS-1 if there is no separate bid item for flagging.

Maintenance work required shall be provided until the Department accepts the Project under Section 105.13.

2. **Special Bypasses.** When the Proposal Form contains an item for "Maintenance of Temporary Bypasses" or "Temporary Bypasses", payment shall cover all costs associated with constructing, maintaining, and obliterating bypasses, including construction and removal of temporary bridges and accessory features. Right of Way for temporary bypasses or bridges designated in the Contract will be furnished by the Department.
3. **Maintenance of Traffic During Suspension of Work.** The Contractor shall make passable and shall open to traffic the portions of the Project and temporary roadways as agreed upon during anticipated periods of suspension. During this suspension period, the maintenance of the temporary route or line of travel agreed on will be the Department's obligation. When work is resumed the Contractor shall replace or restore any work or materials lost or

damaged because of temporary use of the Project, shall remove any work or materials used for temporary maintenance, and shall complete the Project as though its prosecution had been continuous and without interference. The Engineer will determine to what extent the Contractor is obligated to restore the work after a period of suspension.

If construction operations are not resumed on or before the effective date of the Engineer's order to resume work, any costs incurred by the Department for traffic control after the effective date of the order will be deducted from future payments due the Contractor.

4. **Maintenance Directed by the Engineer.** If the Engineer directs special maintenance for the benefit of the traveling public, payment will be as provided in Section 104.03. The Engineer will determine the work to be classed as special maintenance.
5. **Parking of Equipment, Vehicles, and Stored Materials.** The parking of equipment, vehicles, and storing of materials in the median on divided roadways is not permitted. On all roadways, parking and storing of materials may be permitted only if equipment, vehicles, and material are located a minimum of 60 feet from the outside edge of the driving lane.

The Contractor shall not use private property to park vehicles or equipment, to store materials, or as a work area without written permission from the property owner. The Contractor, at his sole expense, shall repair, to the property owner's satisfaction, any private-property damages resulting from the Contractor's activities.

6. **Urban Work.** Where work is performed in a city, the Contractor shall give the Chief of the Fire Department and Chief of Police at least 24 hours written notice before blocking any street. Fire hydrants shall be accessible to the Fire Department at all times. No material or other obstruction shall be placed closer to a fire hydrant than permitted by ordinances, rules or regulations, or within 5 feet of a fire hydrant in the absence of any ordinances, rules, or regulations.

If dust from construction operations becomes a hazard to traffic or a nuisance to the public, a vacuum or pickup sweeper shall be available for controlling dust. If, in the opinion of the Engineer, the dust control provided by the vacuum or pickup sweeper is not adequate, water shall be used in conjunction with the sweeper to control fugitive dust. Washing material into storm or sanitary drainage systems shall not be permitted. Any roadway open to traffic shall be maintained to provide a safe, clean driving surface. All costs for dust control and cleaning (including, but not limited to labor, vacuum, pickup sweepers, water, etc.) shall be incidental to other items bid.

B. Haul Roads.

1. **General.** The requirements for the use, maintenance, and restoration of roads and streets designated as haul roads to haul material to or from the Project shall be as specified in this Section.

All costs, excluding water for dust control, for the maintenance, repair, and restoration of roads and streets not designated as Haul Roads shall be the Contractor's responsibility.

Dust caused by construction or hauling operations on the highway or on designated or undesignated haul roads that creates a hazard to traffic or a nuisance to the public shall be sprinkled with water as necessary to control the dust. This water shall be considered part of the water provided in the Contract for mixing or compaction, and will be paid for as specified in the Contract covering the item of work. When a pay item is not provided in the the Contract, water will be paid for as specified in the Price Schedule PS-1 included in the Proposal Form.

2. **Designation of Haul Roads.** The Engineer shall be notified of each public road or street which is proposed for use as a haul road, before hauling over that route. If the Engineer determines that the road or street is the most practical route for transporting materials, the route will be designated as a "Haul Road" unless deemed unacceptable due to a local jurisdiction request.

A road or street which may be severely damaged by concentrated heavy hauling will not be designated as a Haul Road unless no alternate route is available. The Contractor shall investigate alternate routes before submitting a bid.

If the condition of a road or street is determined unsuitable for hauling, it will not be designated as a Haul Road unless improvements are made before hauling. If the Engineer determines that the pre-haul improvements will reduce haul road restoration costs, the material required to make these improvements will be measured and paid for by the Department.

A designated Haul Road route shall not be changed except by written permission from the Engineer. If the change is requested for the Contractor's convenience, the Engineer may require an agreement limiting the Department's cost liability for maintenance and restoration of the Haul Road.

3. **Pre-Haul Inspection.** Before hauling over a designated route, a joint inspection of the Haul Road will be made by the Engineer, the Contractor, and the Governmental Agency or Political Subdivision charged with control and maintenance of the route. The existing condition of the Haul Road, including the type, thickness, and width of surfacing material in place will be determined and recorded. The inspection report will set forth any special conditions for use, maintenance, and restoration of the route. The report shall be approved and signed by the Contractor, Governmental Agency or Political Subdivision, and Engineer.
4. **Materials.** Materials used for maintenance and restoration of Haul Roads shall meet the following requirements:

Granular material for Aggregate Base or Bituminous Mix shall be an approved aggregate being used on the Project, or may be any one of the following: Classes 4, 5, 8, 13, 27, 29, 31, or 33 as set forth in Section 816.

The type and amount of bitumen used in Bituminous Mix shall be determined by the Engineer, and the method of mixing shall be subject to approval by the Engineer. Bitumen shall meet Section 818 of the Standard Specifications.

Bitumen for Seal (or Prime) shall meet Section 818 of the Standard Specifications. The type of bitumen used and the rate of application shall be determined by the Engineer.

Seal aggregate shall be either Class 41, 43, or 45, as determined by the Engineer to fit the needs of the specific haul road. The seal aggregate used shall meet Section 816 of the Standard Specifications for the specific Class.

Blotter Sand shall meet Class 44 of Section 816 of the Standard Specifications. The rate of application shall be determined by the Engineer.

5. **Use, Maintenance, and Restoration.** While hauling operations are in progress, the haul roads shall be maintained in a condition satisfactory to the Engineer. The Contractor shall comply with all legal load restrictions in hauling materials on public roads.

If the Contractor damages the road through negligence, hauls loads in excess of legal limits, or fails to perform maintenance, the road shall be repaired and restored by and at the Contractor's expense.

When hauling operations over a designated Haul Road are completed, the road shall be restored to a condition at least equal to that existing at the time hauling operations began. The kind and amount of restoration work required and procedures for performing this work will be determined by the Engineer.

The fact that other traffic has used the Haul Road concurrently does not relieve the Contractor's obligation to maintain and restore the road as provided. If any other Contractor used the same route concurrently to haul materials for use on a Department Contract, the Engineer will determine the amount of maintenance and restoration obligation to be shared by each.

Satisfactory restoration of Haul Roads under Department jurisdiction will be accepted by the Engineer in writing, relieving the Contractor of any further obligation in connection with restoration of the road. When restoration work on a Haul Road under other jurisdiction has been completed, the Contractor shall obtain a Haul Road release from the Governmental Agency or Political Subdivision charged with control and maintenance of the route, and a copy of the executed release shall be submitted to the Engineer.

6. **Method of Measurement.** All materials ordered by the Engineer for pre-haul improvements, maintenance, and restoration of Haul Roads will be measured as set forth in the applicable section of the Standard Specifications.
7. **Basis of Payment.** Payment for materials measured as specified will be paid for at the Contract Unit Price whenever the Contract provides a separate pay item for that material. If the Contract does not provide a separate pay item for a specific material, payment will be made according to the unit price listed in the "Price Schedule: PS-1" included in the Proposal Form.

Payment for items ordered by the Engineer that do not have a Contract Unit Price and are not listed in the Proposal Form as noted, will be paid for under Section 104.03.

Separate payment will not be made for costs of blading and reshaping necessary for maintenance and restoration of Haul Roads. This cost shall be included in the price bid for other Contract items.

- C. **Use of Explosives.** Explosives used in the prosecution of the work shall not endanger life or property, including new work. The Contractor shall be responsible for any and all damages resulting from use of explosives.

The Contractor shall comply with all local and state laws and ordinances, as well as with 27 CFR Part 55, and 29 CFR Part 1926, whichever is most restrictive, in the use, handling, loading, transportation, and storage of explosives and blasting agents.

Each public utility company having structures near the work site shall be notified of the intention to use explosives. Notice shall be given 72 hours in advance to enable the companies to protect their property from damage.

- D. **Protection and Restoration of the Property.** The Contractor shall preserve all public and private property and shall not move, disturb, or damage land monuments and property markers until the Engineer has witnessed or otherwise referenced their location.

The Contractor is responsible for damages or injury resulting from any act, omission, neglect, or misconduct in the manner of executing the work, or due to defective work or materials. This responsibility will not be released until the Project has been completed and accepted.

Any direct damage or injury that is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work, or in consequence of the non-execution of the work shall be restored, by and at the Contractor's expense. The property shall be restored to a condition equal to that existing before such damage or injury occurred by repairing, rebuilding, or otherwise restoring, or making good the damage or injury in a manner acceptable to the Engineer, the controlling public agency, or private property owners.

The Contractor shall protect the existing pavement outside of the construction limits during the course of construction. Surface repair which is required because of the Contractor's operations, other than designated haul roads, shall be repaired by the Contractor at the Contractor's expense.

- E. **Responsibility for Damage Claims.** The Contractor shall indemnify and hold harmless the Department, its officers and employees, counties, cities, or other entities or agencies responsible for project supervision, or having jurisdiction over the completed project, and their officers and employees, from suits, actions, or claims brought because of any injuries or damage received or sustained by any person, persons, or property on account of the operations of said Contractor; or on account of or in consequence of neglect in safeguarding the work, or through use of unacceptable materials in constructing the work; or because of any act of omission, neglect or misconduct of the Contractor; or because of any claims or amounts recovered from any infringements of patent, trademark, or copyright; or from any claims or amounts arising or recovered under the Workmen's Compensation Act, or any other law, ordinance, order, or decree. Money due the Contractor under the Contract, may be retained for the use of the Department. In case no money is due, the Surety may be held until such suits, actions, or claims for injuries or damages are settled and evidence to that effect furnished to the Department. Money due the Contractor will not be withheld when evidence shows that the Contractor is adequately protected by public liability and property damage insurance.

It is specifically agreed between the parties executing the Contract that it is not intended by any of the provisions of the Contract to create in the public or any member thereof a third-party beneficiary, or to authorize anyone to maintain any action for personal injuries, death, or property damage pursuant to or arising out of the terms or provisions of the Contract.

F. Personal Liability of Public Officials.

There shall be no liability upon the Director, Engineer, or their authorized representatives, either personally or as officials of the State in carrying out any Contract provisions, or in exercising any power or authority granted to them by or within the Contract's scope. It should be understood that in all such matters they act solely as agents and representatives of the State.

107.06 RAILWAY HIGHWAY PROVISIONS.

- A. Indemnification.** The Contractor agrees to indemnify and save harmless the Railway, from and against all lawful claims, demands, judgements, losses, costs and expenses, for injury to or death of the person or loss or damage to the property of any person or persons whomever, including the parties hereto, in any manner arising from or growing out of the acts of omissions, negligence or otherwise of the Contractor, its successors, assigns, licensees and invitees or agents, in connection with the entry upon, occupation or use of the said premises herein described, including but not limited to that of the location, construction, operation, restoration, repair, renewal, or maintenance of said roadway improvements.
- B. Railway Protection.** If the Contract requires that materials be hauled across railroad tracks, other than existing public crossings, the Department will make arrangements with the railroad for the crossings required. If crossings other than those specified are used, the Contractor shall make arrangements to use the crossings.

All work involving occupation of any track or tracks, encroachment on train clearance requirements, or any other interference with the safe use of tracks shall be performed at such times and in such a manner as not to impede train or switching movements, and shall be subject to time schedules set by the Railroad Company. The Contractor shall notify the Department and Railroad Company at least 10 days before the date on which they propose to start work within the Railroad's Right of Way; and in addition shall notify the Department and Railroad Company at least 24 hours in advance of the time they propose to do any work which may interfere with operation of trains.

The Department and the Railroad Company shall be furnished detailed plans of all false-work, excavation, and cofferdams to be constructed over, below, or adjacent to the Railroad's tracks. No work on these items shall be done until the detailed plans have been approved by the Railroad Company.

The Contractor shall coordinate the need for railroad flagging with the affected railroad, and provide the railroad 48 hours advance notice before flagging operations are needed. If flagging of railroad traffic is required, the Department will reimburse the Railroad Company for the costs incurred and the Contractor will reimburse the Department for these expenses. The costs for this flagging shall be incidental to other items bid.

C. **Railway Protection Insurance.**

1. **General Liability.** The Contractor shall assume all liability and provide primary limited coverage as follows:
 - a. Liability insurance coverage shall be limited to damage suffered by the Railroad because of occurrences arising out of the Contractor's work on or about the Railroad Right of Way, independent of the Railroad's general supervision or control, except as noted in Section (b) 4.
 - b. Coverage shall include:
 - (1) Death of or bodily injury to passengers of the Railway and employees of the Railroad not covered by the State Worker's Compensation laws;
 - (2) Personal property owned by, or in the custody or control of, the Railroads;
 - (3) The Contractor or any of their agents or employees who suffer bodily injury or death as the result of acts of the Railroad or its agents, regardless of the Railroad's negligence;
 - (4) Negligence of only the following classes of Railroad employees:
 - (a) Any supervisory employee of the Railroad at the job site;
 - (b) Any employee of the Railroad while operating, attached to, or engaged on work trains or other Railroad equipment at the job site which are assigned exclusively to the Contractor; or
 - (c) Any employee of the Railroad not within (a) or (b) who is specifically loaned or assigned to the Contractor's work for prevention of accidents or protection of property, where the cost of these services is paid by the Contractor or the Department.
2. **Policy.** The policy shall provide Railroad Protective Liability Insurance for a combined single limit of not less than \$2,000,000 for all damages arising out of bodily injuries to, or death of, any person or persons, and for all damages arising out of loss or destruction of, or injury or damage to, property in any one occurrence during the policy period, and subject to that limitation a combined total (or aggregate) limit of \$6,000,000 for all damages arising out of bodily injuries to, or death of any person or persons, and for all damages arising out of loss or destruction of, or injury or damages to property during the policy period.

D. **Railway Public Liability Insurance.**

The Contractor, for work on the Railway right-of-way, will protect and hold harmless the Railway and any other railroad company occupying or using the Railway's right-of-way or line of railroad against all loss, liability, and damage arising from activities of the Contractor, its forces or any of its Subcontractors or agents, and will further provide the following insurance coverages:

1. Commercial General Liability Insurance to include Contractual liability and products completed operations, against claims arising out of bodily injury, illness and death and from damage to or destruction of property of others, including loss of use thereof, and including liability of the Railway, with minimum limits for bodily injury and property damage of \$2,000,000 for each occurrence with an aggregate of \$4,000,000. This policy shall contain a "Waiver of Transfer Rights" endorsement to waive any right of recovery that the insurance company may have against the Railway because of payment made for bodily injuries or property damage.
2. Business Automobile Policy Insurance, including owned, non-owned, and hired vehicles with minimum limits for bodily injury and property damage of \$1,000,000 per occurrence on all vehicles used while performing any work pursuant to this agreement.
3. Worker's Compensation Insurance as required under the Worker's Compensation Act of North Dakota. If the Contractor is not covered by the North Dakota Worker's Compensation Act, the Contractor shall provide an employer's liability policy. The policy shall include occupational disease to required statutory limits, employer's liability of \$1,000,000 to include FELA (Federal Employees Liability Act), if appropriate, and an "All States" endorsement.

E. General Insurance Requirements.

1. At least 10 days before any work is done on the Railway Right of Way, the Contractor shall procure and furnish to the Department's Construction Engineer (Construction Division, North Dakota Department of Transportation, 608 East Boulevard, Bismarck, ND 58505-0700), the insurance policy or a certified copy of the Railway Protection Insurance Policy. The Contractor shall also procure and furnish a certificate of insurance for the Railway Public Liability Insurance Policies to the Department's Construction Engineer. The Construction Engineer will forward the policies to the Railway Company.
2. The insurance policies shall be executed by a corporation qualified and authorized to write the policies in the State of North Dakota. The policies shall be in a form and substance satisfactory to the Railroad.
3. The insurance shall be in full force and effect before any work is done on the Railway Right of Way and shall remain in full force and effect and not be cancelled by the Contractor until all work required to be done on the Railway Right of Way has been completed, as evidenced by acceptance of the portion of the work by the Department.

- F. Basis of Payment.** Payment for Railway Insurance will be by the Lump Sum unit price bid. Payment shall be for the cost of providing Railway Protective Liability Insurance and the Railway Public Liability Insurance as specified. Payment of the Lump Sum will be made upon approval of the policies by the Railway.

107.07 PUBLIC LIABILITY AND PROPERTY DAMAGE INSURANCE.

- A. Insurance Requirements.** Contractor shall secure and keep in force during the term of the Contract the following insurance coverages:

1. Commercial General Liability for limits not less than \$1,000,000 combined single limit per occurrence and aggregate for bodily injury, property damage, personal injury and completed operations/product liability. Products and completed operations coverage shall be provided for a period of one year following final acceptance of the work. The aggregate limit shall apply separately to occurrences at the location or project to which this Contract relates. The policy shall include a "stop-gap" Employers Liability endorsement to cover the employer's liability for injury to employees which fall outside the State's Worker's Compensation Law.
2. Commercial Automobile Liability for limits not less than \$1,000,000 combined single limit per accident for bodily injury and property damage.
3. Workers Compensation coverage as required by the State of North Dakota.

The General Liability and Automobile policies shall provide an additional insured endorsement in favor of the State of North Dakota and the Owner and shall contain a "Waiver of Subrogation" to waive any right of recovery that the Insurance company may have against the State and the Owner. The coverage required under this agreement shall be primary for the State and the Owner, and shall not be affected by any other insurance or coverage obtained by the State or the Owner on their own behalf.

Any right of the State to receive indemnification and insurance shall not give rise to a duty on the part of the State to exercise its rights or status for the benefit of the Owner, or any other person or entity.

B. General Requirements.

1. The successful bidder shall submit the Certificates of Insurance effecting the foregoing requirements for the General and Automobile Liability Insurance with the Contract and the Contract Bond within ten calendar days after the date of notice of Contract Award.
2. The insurance policies shall be executed by a corporation qualified and authorized to write the policies in the State of North Dakota. The State reserves the right to obtain complete, certified copies of all required insurance documents, policies, or endorsements at any time.
3. The insurance shall be in full force and effect before any work is done on the Project and shall remain in full force and effect and not be cancelled by the Contractor until all work has been completed and accepted by the Department or the Owner. All policies shall provide thirty days notice to the Department or the Owner of any intent to cancel or materially alter such insurance.
4. Failure on the part of the Contractor to maintain the insurance as required shall constitute a material breach of Contract upon which the Department or the Owner may, after giving five working days notice to the Contractor to correct the breach, immediately terminate the Contractor, at its discretion, procure or renew such insurance and pay any and all premiums in connection therewith, with any sums so expended to be repaid to the Department or the Owner on demand, or at the sole discretion of the Department or the Owner, offset against funds due the Contractor from the Department or the Owner.

- C. **Subcontractor.** When a portion of a Contract is sublet, the Contractor shall obtain insurance protection (as outlined in Part A) to provide liability coverage to protect the Contractor, State, and Owner as a result of work undertaken by the Subcontractor. In addition, the Contractor shall ensure that any and all parties performing work under the Contract are covered by public liability and property damage insurance as outlined in Part A.

107.08 HAZARDOUS MATERIAL.

If any abnormal condition is encountered or exposed which indicates the presence of a hazardous material or toxic waste, construction operations shall immediately be suspended in the area and the Engineer notified. The construction operations in this area shall not resume, and work shall be continued in other areas of the Project, unless otherwise directed by the Engineer.

Abnormal conditions include, but shall not be limited to, the following: presence of barrels, obnoxious odors, excessively hot earth, smoke, or any other condition which could indicate hazardous material or toxic waste. The conditions shall be treated with extreme caution.

Disposition of the hazardous material or toxic waste shall be made in accordance with the requirements and regulations of the North Dakota Health Department. Work required to dispose of these materials will be paid for according to Section 104.03. Should waste material disposal require special procedures, the Department will make arrangements with qualified, certified persons to dispose of the material.

107.09 CIVIL RIGHTS.

The Contractor shall comply with federal, state, and local laws, rules, and regulations which set forth unlawful employment practices including that of discrimination because of race, religion, color, sex, or national origin, and which define actions required for Affirmative Action and Disadvantaged Business Enterprise (DBE) programs.

107.10 INERT WASTE DISPOSAL.

- A. This work consists of the proper recycling or disposal of inert material waste on a project. Inert waste includes, but is not limited to; Clearing and Grubbing (as defined in Section 201.02 B), Concrete, Steel, Bituminous Pavements and Pavement Base. For additional information regarding inert waste classification, reference the North Dakota Department of Health – Division of Waste Management’s “GUIDELINE 17 – WASTES EXCLUDED FROM ACCEPTANCE AT LANDFILLS.”

When inert material on a project is designated the property of the Contractor, and the Contractor chooses to waste the material, the material must be disposed in one of two ways:

1. Disposal of the material at an approved permanent waste management facility.
2. If waste cannot be reasonably recycled, reused or managed at an approved landfill, the North Dakota Department of Health may consider allowing a variance for disposal. An “INERT WASTE DISPOSAL VARIANCE

APPLICATION,” SFN 50278, is available from the North Dakota Department of Health – Division of Waste Management. For guidance in filing the application refer to the North Dakota Department of Health – Division of Waste Management’s “GUIDELINE 22A – INERT WASTE DISPOSAL VARIANCE.” Upon approval of the variance, the Contractor shall furnish the engineer with an approved copy, before any material is disposed at the approved site.

Locations of permanent waste facilities, and a variance application and guideline can be obtained at the North Dakota Department of Health – Division of Waste Management, 701-328-5166. A list of municipal and Inert waste landfills is available at the North Dakota Department of Health Web site at: <http://www.health.state.nd.us/ndhd/environ/wm/lists.htm>. Guideline 17 and 22A and other North Dakota Department of Health guidance are available at: <http://www.health.state.nd.us/ndhd/environ/wm/pubs.htm#swpubs>.

- B. If the Contractor fails to comply with all requirements of Section 107.10, the Department reserves the right to:
 1. Suspend progressive estimate payments.
 2. Invoke any other disincentive allowed by the Contract.
 3. Request the North Dakota Department of Health to take any and all enforcement actions provided by applicable law.
- C. Nothing in Section 107.10 shall be construed to prevent the beneficial recycling or reuse of waste materials on this project, as allowed in other sections of the specifications/plans, or on other projects of the Contractor’s choice, including stockpiling the material at a Contractor obtained storage facility so long as the materials are restricted to recyclable inert materials, they are not placed in environmentally sensitive areas such as floodplains, steep areas, wetlands, ravines, etc. and the activities are in accordance with any state and local zoning and health requirements.
- D. Unless a bid item is shown on the Plans, all costs associated with inert waste disposal shall be incidental to the price bid for other items.

SECTION 108 PROSECUTION AND PROGRESS

108.01 PROSECUTION AND PROGRESS.

- A. **Preconstruction Conference.** A preconstruction conference, unless waived by the Engineer, will be held for each Contract at a time and place mutually established by the Contractor and Engineer before any Contract work begins. The Contractor shall notify the appropriate Subcontractors, utility companies, and other interested parties of the time and place of the conference.

B. Progress Schedule. The progress schedule shall be submitted to the Department. This schedule shall establish critical construction operations and will be used to check on work progress. The Contractor shall provide sufficient materials, equipment, and labor to guarantee completion within the time established in the Contract. The progress schedule submitted shall be one of the following:

1. A “bar graph” progress chart shall be submitted within ten days after opening bids. This progress chart shall be prepared according to instructions contained on the Department-furnished form.

If, according to the progress chart, the Contractor is more than 30 days behind schedule on any item, an updated progress chart shall be submitted to the Engineer. Failure to provide an updated progress chart may result in withholding Contract payments until one is submitted.

C. Critical Path Method (CPM) Schedule. When specified, and within the required time frames, a Critical Path Method (CPM) schedule in the specified form shall be submitted. The schedule will be used for coordination, monitoring, and payment of all work under the Contract including all activity of Subcontractors, vendors, and suppliers.

1. The construction of this Project will be planned and recorded with a conventional (CPM) schedule in the form of an activity on arrow diagram or an activity on node diagram. The Contractor shall use *Primavera Project Planner (P3) version 3.1* or newer for Windows to develop and maintain the CPM schedule. This schedule shall be prepared by the Contractor to develop a sequential order of work activities and to determine how rapidly these activities should be prosecuted in order for the Contractor to complete the Project on time. The owner’s review and acceptance of the Contractor’s Project Schedule is for conformance to the requirements of the Contract documents only. Review and acceptance by the owner of the Contractor’s Project Schedule does not relieve the Contractor of any of its responsibility whatsoever for the accuracy or feasibility of the Project Schedule, or of the Contractor’s ability to meet the interim project milestone dates and the Contract completion date, nor does such review and acceptance expressly or impliedly warrant, acknowledge or admit the reasonableness of the logic, durations, manpower, or equipment loading of the Contractor’s schedule.
2. Within 45 calendar days after the Contract execution or prior to the start of work (whichever comes first), the Contractor shall submit an initial CPM schedule. This schedule must cover the first 90 days of project work and must meet all requirements set forth in paragraph 4 below. Within 60 calendar days after the Contract execution, the Contractor shall submit a CPM schedule for the entire project that meets all requirements set forth in paragraph 4 below. The construction time for the entire Project or any milestone, shall not exceed the specified Contract time.

Milestone date or Contract completion date shall not be exceeded in the initial CPM schedule, logic, and/or time estimates.

3. **CPM Schedule Requirements:** The CPM schedule shall be in the form of an activity on arrow diagram, an activity on node diagram, or approved equal. All diagrams shall include; activity nodes, activity descriptions, activity

durations, activity start and finish dates, and float. The diagram shall show the sequence and interdependence of all activities required for complete performance of all items of work under this Contract, including work drawing submittal and approvals and fabrication and delivery activities. All relationships shall be finish to start, finish to finish, start to finish, or start to start. All network “dummies” are to be shown on the diagram.

No activity duration shall be longer than 15 working days without the Engineer’s approval. The Engineer reserves the right to limit the number of activities on the CPM schedule.

The activities are to be described so that the work is readily identifiable and the progress of each activity can be readily measured. For each activity, the Contractor shall identify the entity performing the work, the duration of the activity in working days, the manpower involved, the equipment involved, and the location of the work.

Any diagram submitted by the Contractor shall be electronically created. The network must be legible and self explanatory. Network diagrams will be on standard D size sheets (24” × 36”).

For both the initial CPM schedule and all updates, the Contractor shall provide the following:

- a. Sorts by:
 - (1) I-J (Beginning & Ending node no.) or Activity ID
 - (2) Total Float
 - (3) Early Start
- b. A narrative including the following:
 - (1) The progress to date on the Project.
 - (2) A description of each active critical path activity which includes the following:
 - (a) Time expired of the activity duration.
 - (b) An estimate of percent complete.
 - (c) The method by which an activity that is behind schedule will be returned to the original schedule. The method shall be in terms of construction method, equipment, manpower, or hours.
 - (3) A description of the work required up to the next update.
 - (4) Any inputs that differ from the original CPM schedule such as: the work days per week, holidays, number of shifts per day, number of hours per shift, and major equipment used.
- c. Three copies of each of the above.

d. An electronic copy of the schedule file on a standard compact disc.

4. **Schedule Updates:** An updated CPM schedule shall be submitted the first working day of each month after the initial CPM is accepted by the department. Job site progress meetings will be held every week by the Contractor and the Engineer for the purpose of reviewing the CPM schedule. Progress will be reviewed to verify the dates activities were completed, remaining duration of uncompleted activities, and any proposed logic and/or time estimate revisions.

The Contractor shall revise CPM diagrams for any one of the following:

- a. Delay in completion of any critical activity.
- b. Actual prosecution of the work which is different than that represented on the schedule.
- c. The addition, deletion, or revision of activities.

The CPM revision shall be due within two weeks of any of the above such occurrences.

A Contract modification or delay may result in absorbing a part of the available total float that may exist within an activity chain on the network, thereby not causing any effect on any interim milestone date or the Contract Completion Time.

It is understood by the Engineer and the Contractor that float is a shared commodity. Total float is defined as the amount of time between the early start date and the late start date, or the early finish date and the late finish date, for each and every activity in the schedule. Float is not for the exclusive use or benefit of either the owner or the Contractor. Extensions of time to interim milestone dates or the Contract Completion Time under the Contract will be granted only to the extent that the equitable time adjustments to the activity or activities affected by the Contract modification or delay exceeds the total float of the affected activity or subsequent paths and extends any interim milestone date of the Contract Completion Time.

Activity delays shall not automatically mean that an extension of the Contract Completion Time is warranted or due the Contractor. A Contract modification or delay may not affect existing critical activities or cause non-critical activities to become critical.

The principles involved and terms used in this Section are as set forth in the Associated General Contractors of America publications, "The Use of CPM in Construction, A Manual for General Contractors and the Construction Industry," latest edition, and "Construction Planning and Scheduling," Copyright January 1994.

5. **Method of Measurement:** The unit of measure for the CPM schedule, including all required revisions, shall be "Lump Sum."
6. **Basis of Payment:** Payment will be made at the Contract Unit Price for the following:

Pay Item
Critical Path Method Schedule

Pay Unit
Lump Sum

The Contractor will receive 25 percent of the Lump Sum price bid when the initial CPM schedule is accepted as meeting the requirements of this special provision, and will receive prorated payments for the remainder of the bid price, based on the number of monthly payments anticipated during the Contract. The prorated payments may be adjusted to compensate for any approved adjustments to the completion date.

Failure to submit a CPM schedule that meets the Contract requirements within 60 days after the Contract execution will result in withholding all or any part of the Contract payments until the CPM schedule is finalized.

Failure to submit a CPM schedule update to the Engineer within two calendar days of its due date, will result in a Contract Unit Price Adjustment. The adjustment will be a 5 percent deduct of the CPM Schedule bid item for each update that is late. Failure to submit a revised CPM schedule as specified may also result in withholding all future Contract payments until the revised schedule is submitted. The revisions shall include all activities.

Payment will be full compensation for the CPM schedule, diagrams, updates, and progress meetings as necessary to complete the work.

108.02 NOTICE TO PROCEED.

The mailing or delivery of a copy of the executed Contract to the Contractor or authorized agent constitutes the "Notice to Proceed."

The Contract document's "time for completion" stipulates when time charges are to start on working day and completion day with guaranteed working day Contracts.

If the Contractor does not proceed as specified, the provisions of Section 108.05 will be applied.

108.03 LIMITATION OF OPERATIONS.

Construction shall be conducted in a manner and sequence to minimize interference with traffic, and with due regard to location of detours and provisions for handling traffic. The Contractor shall not begin work to the prejudice or detriment of work already started, and the Engineer may require a section of roadway to be finished before starting additional sections if the opening of the section is essential to public convenience.

If the prosecution of the work is discontinued, the Engineer shall be provided at least 24-hours notice before resuming operations.

No work on Sundays or Legal Holidays will be permitted unless specified in the Contract, or written permission is obtained from the Engineer.

108.04 DETERMINATION AND EXTENSION OF Contract TIME.

A. **Contract Time.** Time allowed for completing Contract work may be a fixed calendar date or a specified number of working days as stated in the Contract. Contract time will be adjusted according to this Section.

B. Working Day Contracts.

1. The maximum number of working days allowed for completion of the work will be stated in the Contract.
2. Working days will be counted from the starting date stated in the Contract or from the actual date on which on-site work is started, whichever is earlier. If execution of the Contract is delayed for reasons beyond the Contractor's control, the starting date for time charges will be amended to no earlier than the seventh calendar day after the execution date of the Contract or the date on-site work is started, whichever is earlier.
3. A working day will be charged for each calendar day (except as provided here for Saturdays, Sundays, legal holidays, and the period from November 15 to April 15) that work can be effectively prosecuted on the controlling operations for a minimum of seven hours. If work on the controlling operations is limited by conditions beyond the Contractor's control, to more than three hours but less than seven hours, 1/2 working day will be charged; for three hours or less, no time will be charged.
4. No working days will be charged for work performed on subsidiary items when weather or other conditions beyond the Contractor's control do not allow prosecution of the work on the controlling operations.
5. No working days will be charged for Saturday unless the Contractor elects to work, in which case time charges will be evaluated as for a normal work day. If the Contractor receives permission and works on a Sunday or legal holiday, time charged will be evaluated as for a normal work day. No working days will be charged from November 15 to April 15 inclusive even if work is performed.

C. Completion Date Contracts.

1. The Contract completion date shall be the fixed calendar date specified for completion of Contract work.
2. When the completion date Contract guarantees a stated minimum number of working days to complete the work, working days will be counted as provided for a working day Contract as stated in Section 108.04 B. If the number of working days counted between that date and the specified completion date are less than the guaranteed number, the completion date will be extended until the guaranteed number of working days have been counted.
3. When the completion date Contract does not guarantee a stated minimum number of working days for performance of the work, adverse weather will not be considered a basis for extension of the completion date. When the Contractor selects the starting date and schedule of progress, it will be understood that consideration was given to the effect of adverse weather; job problems which could be foreseen at the time of bid letting; and the exception of Sundays and legal holidays.

D. Increased Work. The Contract time is based upon completion of the original quantities of work or as defined in Section 102.05. If satisfactory completion of

the Contract requires extra work of a type not included in the original Contract or requires an increase in quantities established in the Proposal, the Contract time will be extended on a basis commensurate with the amount and difficulty of the added work. For working day Contracts, the number of working days allowed for completion will be increased by the greater of: (1) a ratio equivalent to the percentage increase in Contract cost (except as noted below for additives), or (2) the Engineer's estimate of the number of working days required to perform the additional work. For completion date Contracts, or completion date Contracts with guaranteed working days, the additional time for completion will be based on the Engineer's estimate of the number of days required to perform the extra work.

Increases or decreases in the quantity of additives such as lime, fly ash, cement, or bitumen used in soil or base stabilization, or in concrete or bituminous mixtures will not be a basis for determining the extension of Contract time.

- E. **Delayed Delivery of Materials.** The Contract time may be extended due to delays in delivery of critical materials caused by national emergency, strikes, embargoes, area-wide shortages, or other reasons beyond the Contractor's control. The Contractor shall immediately notify the Engineer in writing when the controlling operation may be delayed due to delivery of critical materials. Delays in material delivery due to financial considerations, delayed placement of orders, or other conditions are considered within the Contractor's control and will not constitute a basis for extension of the Contract time.
- F. **Other Delays.** The Contract time may be extended if work is delayed for reasons beyond the control and without the fault or negligence of the Contractor. If the Contractor deems that a time extension is warranted, the Contractor shall promptly notify the Engineer in writing that additional time is requested. Reasons for a time extension may include, but are not restricted to: Acts of God or of the public enemy, acts of governmental authority, acts of the State or political subdivision, embargoes, labor disputes, and work suspensions ordered for the public interest, or other reasons not related to the Contractor's performance.
- G. **Request for Additional Time.** At any time before expiration of the original or extended Contract time, a written request may be made to the Engineer for additional time to complete the Contract. The request shall be supported by adequate documentation stating the reasons and basis for the request. The Engineer's determination will consider to what extent the delays were caused by conditions beyond the Contractor's control that may be offset by time lost due to the failure to diligently prosecute the work or to other conditions within the Contractor's control. A plea that insufficient time was specified is not a valid reason for a time extension. A time extension will not be considered for inclement weather or for the time period from November 15 to April 15, even if the the progress chart indicated that work was planned for this time period.
- H. **Conversion of Days.** When conversion of working days to calendar days or calendar days to working days is necessary, the factor for making such conversions shall be as follows; seven divided by the number of working days specified to be counted per week equals the conversion factor for converting working days to calendar days. The inverse of this formula shall be used when converting from calendar days to working days.
- I. **Weekly Statement of Time Charges.** After time charges against the Contract begin, the Engineer will furnish the Contractor with a weekly statement showing

the number of working days charged to the project for the preceding week and the total number of days charged to date. If the Contractor disagrees with the time charges shown on the weekly statement, a written notification must be given to the Engineer within seven calendar days after the last day of the week covered by the report detailing the reasons the statement is incorrect. Failure to provide the written notification will be considered the Contractor’s acceptance of the time charges as shown on the weekly statement and will constitute a waiver of claim for additional time.

- J. **Failure to Complete on Time.** For each calendar day or working day that any work remains uncompleted after the specified Contract time or approved extension has elapsed, the applicable sum listed in this Section will be deducted from money due the Contractor. This sum shall not be considered and treated as a penalty but as liquidated damages due the Department for inconvenience to the public, added cost of engineering and supervision, and other items which cause an expenditure of public funds for the Contractor’s failure to complete the work on time.

Schedule of Liquidated Damages.

Original Contract	Amount Liquidated Damages	
Over - To & Including	Calendar Day	Working Day
\$ 0 - \$ 50,000	\$ 200	\$ 300
50,000 - 100,000	400	500
100,000 - 250,000	600	800
250,000 - 500,000	750	1,000
500,000 - 1,000,000	900	1,300
1,000,000 - 2,000,000	1,100	1,550
2,000,000 - 3,000,000	1,300	1,800
3,000,000 - 5,000,000	1,550	2,100
5,000,000 - 8,000,000	1,900	2,600
8,000,000 - Up	2,400	3,200

Liquidated damages for failure to complete the work on time will be based on the working day charges for working day Contracts, or on the calendar day charges for completion day Contracts and completion date Contracts with guaranteed working days.

Except on Completion Date Contracts or if otherwise stated in the Contract, liquidated damages will not be charged on any Contract during the period from November 15 to April 15 inclusive, nor during periods when the Project is in an authorized state of suspension.

On Completion Date Contracts, assessment of liquidated damages will continue until all work is completed except during periods of authorized suspension.

Permitting the Contractor or Surety to continue and to finish the work after the specified Contract time or approved extension has elapsed shall not be deemed as a waiver by the Department of any rights under the Contract.

The Department may suspend or reduce time charges after the Department has determined the work is substantially complete and in condition for safe and conven-

ient use by the traveling public. The project will be considered substantially complete when all necessary signing, striping, guardrail, and other safety appurtenances have been installed. For projects which will not be open to the traveling public, the project will be considered substantially complete when it is ready for the subsequent project. The suspension of time charges shall not be construed as a Contractual right of the Contractor, and its application will be contingent upon the Contractor's diligence in completing the remaining items of work.

- K. Unsatisfactory Progress.** If satisfactory progress according to the proposed progress schedule submitted is not being made, the Engineer may arrange a meeting between the Contractor, the Contractor's Surety, and authorized Department representatives to discuss the work and to devise and arrange certain steps and procedures to be followed to restore the progress of the work to a satisfactory status conforming to the progress schedule.
- L. Incentive/Disincentive Provisions.** If it is in the traveling public's interest to have an early completion date, an incentive/disincentive provision may be established in the Contract. Completion requirements and details, and monetary payments and charges will be as specified in the Contract.

Section 108.04 J relating to liquidated damages will remain in effect.

108.05 DEFAULT AND TERMINATION OF CONTRACT.

If the Contractor:

- A. Fails to begin the work under the Contract within the time specified; or
- B. Fails to perform the work with sufficient resources to assure the prompt completion of the work; or
- C. Fails to perform the work satisfactorily or neglects or refuses to remove or replace rejected materials, or unacceptable work; or
- D. Discontinues the prosecution of the work; or
- E. Fails to resume work, which has been discontinued, within a reasonable time after notice to do so; or
- F. Becomes insolvent or is declared bankrupt, or commits any act of bankruptcy or insolvency; or
- G. Allows any final judgment to be unsatisfied for 10 days; or
- H. Makes an assignment for the benefit of creditors without the Engineer's approval; or
- I. For any other cause, fails to carry on the work in an acceptable manner;

The Engineer may give notice in writing to the Contractor and Surety of such delay, neglect, or default.

If the Contractor or Surety does not proceed to comply within 10 days after such notice, the Department will (upon written notification from the Engineer of the fact of the de-

lay, neglect, or default) have full power and authority without violating the Contract to take the prosecution of the work out of the hands of the Contractor. The Department may appropriate or use any or all materials and equipment at the work site and may enter an agreement to complete the Contract according to its terms and provisions. The Department may use other methods required to complete the Contract in an acceptable manner.

All costs and charges incurred by the Department, together with the cost of completing the work under Contract, will be deducted from any monies due or which may become due the Contractor. If expenses exceed the sum which would have been payable under the Contract, the Contractor and the Surety shall be liable and shall pay the Department the amount of such excess.

If a notice of termination for default has been issued and it is later determined, for any reason, that the Contractor was not in default, the rights and obligations of the parties shall be the same as if the notice of termination had been issued pursuant to Section 108.06.

108.06 TERMINATION OF CONTRACT.

The Department may, by written order of the Engineer, terminate the Contract or any portion of it after determining that for reasons beyond either Department or Contractor control, the Contractor is prevented from proceeding with or completing the work as originally Contracted for, and that Contract termination would be in the public interest. Reasons for termination include, but are not limited to: Executive Orders of the President relating to prosecution of war or national defense; national emergency which creates a serious shortage of materials, labor, equipment, or funds which will continue for an unreasonable length of time; orders from duly-constituted authorities relating to energy conservation; restraining orders or injunctions obtained by third-party citizen action, or where the issuance of such order or injunction is primarily caused by acts or omissions of persons or agencies other than the Contractor; changes in funding availability at either the State or Federal level; changes in Department priorities from any cause; act of God; or other circumstances beyond the control of the Contractor. The rights accorded the Department and the Contractor by this section shall not supersede or include other specific rights and responsibilities of each contained in the Contract.

When the Department orders termination of a Contract effective on a certain date, all completed items of work as of that date will be paid for at the Contract bid price. Payment for partially-completed work will be made according to Section 104.03.

Materials which have not been incorporated into the project may be purchased from the Contractor at the actual delivered cost to a prescribed location or disposed of as mutually agreed. All material purchased by the Department shall have been inspected, tested, and accepted by the Engineer and properly stored and maintained by the Contractor.

After receipt of notice of termination, the Contractor shall submit a claim as per Section 104.06 B for additional damages or costs not covered previously or elsewhere in the Contract. The claim shall be submitted within 60 days of the effective termination date. The claim may include such cost items as reasonable idle equipment time, mobilization efforts, overhead expenses attributable to the Project terminated, Subcontractor costs not otherwise paid for, actual idle labor cost if work is stopped in advance of termination date, guaranteed payments for private land usage as part of the original

Contract, and any other actual cost or damage item which the Contractor has incurred. The loss of anticipated profits will not be considered a legitimate item or part of any settlement.

The Contractor agrees to make all cost records available to the Department for determining the validity and amount of each item claimed, and to provide a basis for negotiating an equitable settlement.

Termination of a Contract or portion thereof shall not relieve the Contractor of any Contractual responsibilities for the work completed, nor shall it relieve the surety of its obligation for and concerning any just claim arising out of the work performed.

SECTION 109 MEASUREMENT AND PAYMENT

109.01 MEASUREMENT OF QUANTITIES.

All work completed under the Contract will be measured by the Engineer according to United State's standard measure.

- A. Longitudinal measurements for area computations will be made horizontally, and deductions will not be made for individual fixtures having an area of 9 square feet or less. Transverse measurements for area computations will be the dimensions shown on the Plans.

Miscellaneous items which are placed on slopes will be measured by the square yard on the slope.

- B. Structures will be measured according to lines shown on the Plans or as altered to fit field conditions.
- C. All items measured in linear units such as pipe culverts, guardrail, underdrains, etc. will be measured parallel to the base or foundation upon which the structures are placed.
- D. In computing volumes of excavation, the average end area method, prismatic method, or other acceptable methods will be used.
- E. The term "ton" will mean the short ton consisting of 2,000 pounds. All materials measured or proportioned by weight will be weighed on accurate, approved scales at locations designated by the Engineer. If material is shipped by rail, the car weight may be accepted provided only actual weight of material will be paid for. Car weights will not be acceptable for material processed through mixing plants. Trucks used to haul material will be weighed empty at times directed by the Engineer, and shall bear a plainly legible identification mark.
- F. Materials measured by volume shall be hauled in approved vehicles and measured at the point of delivery. Vehicles may be of any size or type, provided the body is

shaped so the actual contents may be readily and accurately determined. All vehicles shall be loaded to their water capacity where possible. The Engineer may require the loads to be leveled at the delivery point to determine that actual volume of the load. Vehicles shall not haul loads that exceed the gross weight legal load limits.

- G. When approved by the Engineer in writing, material specified to be measured by volume may be weighed and converted to volume for payment purposes; or material specified to be weighed may be measured by volume and converted to weight for payment purposes. Factors for conversion from weight to volume or vice versa will be determined by the Engineer and shall be agreed to by the Contractor before this method of measurement is used.
- H. Bitumen will be measured by the ton or gallon. Volumes will be measured at 60°F. or will be corrected to the volume at 60°F. using the volume corrections shown in the Department's Construction Manual. Measurements will be made at the delivery point of the material to the Project. Deductions will be made for number of gallons which are neither placed on the road surface nor disposed of as designated by the Engineer.
1. When the bitumen is transported directly from the refinery to the Project in distributor or transport trucks and trailers, each vehicle used shall be weighed before and after loading on scales furnished by the supplier or on public scales accessible to the source; or before and after unloading on the Contractor's scales or on public scales accessible to the work. The scale shall be tested and sealed by a State Agency as often as required by the State in which the scale is located.
 2. Where bitumen is weighed at the source, the tanks shall be sealed by the supplier; and the type of bitumen, specific gravity and the gross, tare, and net weights shall show on the shipment manifest. The shipment manifest shall be signed by a refinery representative or an inspector hired by the Engineer. Truck transports not sealed must be weighed before and after unloading of bitumen at the unloading point.
 3. Bitumen may be measured by the ton and the amount converted to gallons, or it may be measured by the gallon and converted to tons. The conversion factor will be determined from the specific gravity of the material.
 4. The bitumen measured as provided will be paid for at the Contract Unit Price when the material has been tentatively accepted and used, and one of the following conditions exist:
 - a. The original sample of the bitumen meets all requirements of the governing Specifications.
 - b. The original sample of the bitumen may have failed to meet requirements of the governing Specifications, but the check sample meets requirements of the governing Specifications.
 - c. The check sample may fail to meet one quality requirement of the governing Specifications, but it does meet the quality requirement the original sample failed to meet.

5. For all asphalts except Performance Graded (PG) asphalt, when both samples of bitumen fail to meet any of the governing Specifications except penetration and demulsibility, but the quality deviation is not serious enough to materially affect the work quality, payment for the bitumen will be reduced at a rate of 20 percent of the invoice price (FOB refinery) per gallon or per ton, for the quantity of bitumen represented by the failing sample. If more than one of the governing specifications fails to meet the specified requirements, the price adjustment will be based on the lowest pay factor determined.

a. Penetration.

If only the penetration of the bitumen fails to meet the governing Specifications, the following deductions will apply to the invoice (FOB refinery) price for bitumen: (The initial sample and the check sample must fail before a deduct is applied. The percentage of variation will be determined by averaging the penetration of both failing samples.)

Variation of Penetration	Deduct Factor
0.1 - 5 percent	5 percent
5.1 - 10 percent	10 percent
10.1 - 15 percent	25 percent
Greater than 15 percent	50 percent

b. Demulsibility.

If the demulsibility of the emulsified bitumen fails to meet the governing Specifications, the following deduction will apply to the invoice (FOB refinery) price for bitumen: (The initial sample and the check sample must fail before a deduct is applied. If both samples fail, the percentage of variation will be determined by averaging the demulsibility of both samples.)

(Deviation from specified value) 0.67 = percent Deduct Factor

6. If the Engineer determines the bitumen has affected the work quality adversely to the extent corrective work is required, no payment will be made for the bitumen.
7. If the tests show the bitumen is not in accordance with the Specifications and the material has not been unloaded, the bitumen will not be accepted.
8. The Engineer reserves the right to weigh any load or loads when delivered to the project.
9. The price adjustments for Performance Graded (PG) Asphalts that fail to meet Section 818.02 A.3 shall be as defined in the *NDDOT Procedure for Acceptance of Performance Graded Bituminous Material*. The *NDDOT Procedure for Acceptance of Performance Graded Bituminous Material* is on file at the Materials and Research laboratory.
- I. Cement will be measured by the ton.
- J. Timber will be measured by the thousand board feet measure. Measurement will be based upon nominal widths and thicknesses and the extreme length of each piece.

- K. The term “lump sum,” when used as an item of payment, will mean complete payment for the work described in the Contract.
- L. When a complete structure or structural unit (in effect, “lump sum” work) is specified as the unit of measurement, the unit shall include all necessary fittings and accessories.
- M. Payment for equipment rental will be made according to rates and instructions listed in the schedule *Rental Rates for Equipment and Traffic Control Devices* published by the Department.
- N. When standard manufactured items are specified, such as fence, wire, plates, rolled shapes, pipe conduit, etc.; and these items are identified by gauge, unit weight, section dimensions, etc.; such identification will be considered to be nominal weights or dimensions. Unless more stringently controlled by tolerances in cited Specifications, manufacturing tolerances established by industries involved will be accepted.

109.02 SCOPE OF PAYMENT.

The Contractor shall receive and accept compensation as full payment for furnishing all materials and for performing all work under the Contract in a complete and acceptable manner including all risk, loss, damage, or expense rising out of the nature or prosecution of the work, subject to Section 105.14.

If the “Basis of Payment” clause in the Specifications relating to any unit price in the bid schedule requires that the unit price include and be considered compensation for certain work or material essential to the item, this same work or material will not be measured or paid under any other pay item which may appear elsewhere in the Specifications.

109.03 FREIGHT RATES.

Changes in carrier rates or in the cost of any other transportation facilities used for the material during the life of the Contract shall not constitute cause for claiming extra compensation.

109.04 FORCE ACCOUNT.

It is intended that payment under Force Account will be for small scale, additional work as directed in writing by the Department. It is not intended that the Force Account rates and requirements be used as a method for pricing of changed quantity work, differing site condition work, eliminated items, additional compensation for suspension or delay of work, or request/claim work that falls under Section 104.03 A, B, C; 104.04; 104.05; and 104.06.

- A. **Labor.** The Contractor will be reimbursed for the actual wages and health and welfare benefits paid to all laborers, and all supervisors in direct charge of specific operations, for each hour they are engaged in the Force Account work, but not to exceed any rate of wage agreed to before beginning the work.

In addition, an amount equal to 75 percent of the wages and health and welfare benefits for Force Account work performed on bridges and reinforced concrete

box culvert projects, or 70 percent of the wages and health and welfare benefits for Force Account work on all other types of projects, will be paid. This amount shall be considered as full compensation for the following items: profit, overhead, pension fund, fringe benefits, bond, insurance, worker's compensation, unemployment insurance, social security taxes, and any other labor additives the Contractor pays. The actual cost paid to, or in behalf of, workers for subsistence and travel allowance will be added to the labor costs. Payment for subsistence and travel must be accounted for on Contractor-submitted payrolls or by certified letter. The labor additive rate specified above will not be applied to the subsistence and travel allowance.

- B. **Materials.** For all materials accepted by the Engineer and permanently installed into the work, the actual cost (including transportation charges paid by the Contractor) of the material delivered will be paid, to which a sum equal to 15 percent will be added. For materials used in connection with (but not entered permanently into) the work, a reasonable depreciation will be allowed.
- C. **Equipment.** Payment for use of authorized equipment and additional traffic control devices required by the Force Account work will be based on rental rates determined according to the then current issue of the Department publication entitled *Rental Rates for Equipment and Traffic Control Devices*. This publication shall constitute a part of this Specification. Rates determined shall be agreed to in writing on the standard agreement form furnished by the Department. No percentage will be added to these rates.

Procedures governing rented or owner-operated equipment, attachments and accessories, types and quantity of equipment, measurement of equipment time, use of equipment in excess of 50 hours per week, stand-by time, and equipment transportation charges will be as set forth in the Department's publication *Rental Rates for Equipment and Traffic Control Devices*.

- D. **Miscellaneous.** No additional allowance will be made for use of small tools not listed in the rental rate schedule or other costs for which no specific allowance has been provided.
- E. **Subcontracting.** For any Force Account work performed by a Subcontractor with the written authorization of the Engineer, the Contractor will receive an additional allowance for administrative and overhead expense. The additional allowance will be a percentage of the Force Account work performed by the Subcontractor equal to 10 percent of the first \$15,000 plus 5 percent of the balance in excess of \$15,000.
- F. **Authority of Engineer.** The Engineer has authority to require alterations in equipment and labor force assigned to Force Account work. The Engineer is authorized to limit overtime work to that normally used on the project for work of similar nature, to require overtime when an emergency exists, and to require the stopping of Force Account work when adverse conditions limit productivity.
- G. **Daily Records.** Each day the Contractor's representative and the Engineer shall compare and reconcile the records of labor, materials, and equipment used in the Force Account work.
- H. **Statements.** The Contractor shall furnish the Engineer with duplicate itemized statements of the cost for the Force Account work, detailed as follows:

1. Payroll for laborers and foreman.
2. Quantities of materials, prices, extensions, and transportation costs paid by the Contractor.

Statements shall be accompanied by paid receipted invoices for materials used, including transportation charges paid by the Contractor. The statements shall be adjusted when applicable to reflect any discounts offered by the supplier. If materials used in the Force Account work are not specifically purchased but are taken from the Contractor's stock, an affidavit shall be furnished certifying that the materials were taken from stock, that the quantity claimed was actually used, and that the price and transportation costs claimed are the Contractor's actual costs. After receipt of statements and invoices, the Engineer will prepare a summary statement of the Force Account work which will be submitted to the Contractor for verification and signature. The value of the Force Account work covered by approved statements will be included in progressive estimates.

- I. **Compensation.** Compensation provided by previous provisions of this Section shall be accepted by the Contractor as payment in full for work performed on a Force Account basis.
- J. **Specialty Work.** When a special service or item of work cannot be performed by the Contractor or authorized Subcontractors, the service or Extra Work item may be performed by a specialist. Invoices for the work may be based on current market price without complete itemization of labor, material, and equipment cost when it is not practicable and not according to established practice of the special service industry to provide complete itemization. To compensate for administrative and overhead costs, an allowance will be added to the speciality work invoice equal to 10 percent of the first \$5,000 plus 3 percent of the balance in excess of \$5,000.
- K. **Payment.** Force Account payments will be made within 30 days after receiving all the required information.

109.05 PARTIAL PAYMENT.

- A. **Partial Payment.** Partial payment will be made at least once each month as the work progresses. Payments may be made twice a month or more often if the Engineer determines the amount of work performed is sufficient to warrant such payment. Payments will be based on estimates prepared for the value of the work performed, and for materials delivered according to Section 109.06.

Failure to perform any of the obligations under the Contract will be considered adequate reason for withholding any payments until compliance is achieved.

From the total amounts payable, 4 percent of the whole will be deducted and retained by the Department. The balance of 96 percent, less all previous payments, will be certified for payment. After 50 percent of the work has been completed, the Department may make any remaining partial payments in full as long as 2 percent of the total Contract price is retained.

After 90 percent of the work has been completed and:

1. all pit releases, receipts of payment, and haul road releases are on file with the Department; and
2. all payrolls have been submitted and are up to date; and
3. the remaining work can be completed without accrual of liquidated damages; and
4. the Contractor is making a diligent effort to complete the work remaining on the project;

The Engineer may prepare a semifinal estimate for the work completed and retain not less than 1 percent of the dollar amount of work completed. The remainder, less all previous payments, will then be certified for payment.

After all original Contract work is completed and conditions 1 through 4 above have been met, the Engineer may prepare a semifinal estimate for the work completed and retain less than one percent of the dollar amount of work completed. The actual amount of retainage must be approved by the Construction Engineer.

Payments authorized under this section shall not constitute final acceptance of any portion of the project. The Contractor shall be responsible for final delivery of the project as specified in the Contract documents, regardless of any payments made.

- B. Prompt Payment.** The Prime Contractor must pay the Subcontractor the amount due for work done or services rendered, less applicable retainage not to exceed 2 percent, from the current progress payment within 20 calendar days of receipt of payment from the Department or owning agency, unless the Prime Contractor has just cause to not make payment. If the Prime Contractor withholds payment from the Subcontractor, the Prime Contractor must **immediately notify** the Subcontractor and the Project Engineer, in writing, the reasons for withholding payment. The Subcontractor may also notify the Engineer if prompt payment has not been made.

If the Department or owning agency determines the Prime Contractor is withholding payment without just cause, interest will accrue at the rate provided by NDCC 1301.1-02. The Prime Contractor is responsible for paying the accrued interest starting on the twenty-first calendar day after the Prime Contractor receives payment. If the Prime Contractor is withholding Subcontractor payments without just cause, the Department or owning agency may suspend all payments due to the Prime Contractor, until the Subcontractor is properly paid and the Contractor agrees to make payments as specified. If the Department or owning agency determines there is just cause for withholding payment, interest will not accrue on the amount due.

These prompt payment procedures apply to all tiers of Subcontracts and are based on 49 CFR 26.29

- C. Retainage.** The Department or owning agency will determine whether the Subcontractor's work has been "satisfactorily completed." A Subcontractor's work is satisfactorily completed when all of the tasks called for in the Subcontract have been accomplished, documented in accordance with the Contract, and paid for on

a pay estimate. To be satisfactorily complete, a Subcontractor must provide all necessary final documentation required in the Contract. Final documentation may include, but is not limited to: certified payrolls, materials certification, haul road releases, pit receipts of payment, pit releases, night watchman reports, warranties, operating manuals, product literature, verification of final quantities, and the DBE Certification (SFN 14268).

If the Prime Contractor elects to use retainage on Subcontract work, prompt payment shall also include the release of retainage monies that have been withheld from the Subcontractor within 20 days after the Subcontractor's work is satisfactorily completed. Non-bonded Subcontractors must submit proof of payment for all material bills and wages to the Prime Contractor before the Prime Contractor is required to pay the retainage. If retainage is not released as per this provision, interest will accrue at the rate provided by NDCC 13-01.1-02 beginning the twenty-first calendar day after the Subcontractor's work is satisfactorily completed.

The release of retainage applies to all tiers of Subcontracts.

- D. **No Circumvention.** On federal-aid Contracts the Contractor shall not include any provision in its Subcontract that would circumvent 49 CFR Part 26.29.

109.06 PAYMENT FOR MATERIAL ON HAND.

Payment will not be made for materials delivered to, or stockpiled on, the project until incorporated in the work in their final position, except as specified in this Section.

Requests for payment of material on hand shall be submitted in writing to the Engineer. A delivery invoice itemizing the material must be supplied for all stockpiled materials, except materials manufactured by the Contractor. A statement from the Contractor certifying that the material meets specifications, or in the case of stockpiled aggregate, that it will meet specifications at the time of placement, is required for payment of material on hand. For Contractor manufactured materials to be eligible for payment, a fully documented statement of production costs; including the type of material, amount of material stockpiled, location of stockpile and itemized breakdown of the cost for producing the material shall be submitted to the Engineer.

The Contractor shall furnish paid invoices for all stored materials that have not been incorporated into the permanent work within 35 days of the date the Department submitted the estimate for payment. An estimate submitted for payment date is shown on the top of the detail pages. The paid invoice shall include a notarized statement from the supplier or fabricator certifying that payment has been received. If a paid invoice is not furnished, the quantity of any previously allowed material remaining in storage will be deducted from the next progressive estimate, and further payment will not be made until the material is incorporated into the work.

Payment for material on hand will be limited to the appropriate portion of the value of the Contract item and will not exceed the Contract Unit Price for the work item in which the material is used. Payment will not be made for materials in excess of Plan quantities. As materials are used in the work, credits equaling the partial payments for them will be taken on future estimates.

To be eligible for payment, the value of the stored material to be used in one item of work must exceed \$2,000.

Payment for material on hand will not include payment for fuels, supplies, form lumber, falsework, temporary structures, or other materials which will not become an integral part of the finished work item.

No partial payment will be made on living or perishable plant materials until planted.

The material shall be delivered to or stockpiled near the project or other Engineer-approved storage facility.

Payment may be made for structural steel to be used on bridge girders prior to fabrication. Structural steel stockpiled at production plants or fabrication sites must be stored separately to qualify for payment and shall be used only for the assigned Contract. Payment will not be made for reinforcing steel prior to fabrication.

If stored material is lost, stolen, or damaged, the materials value will be deducted from the subsequent estimate or estimates. Payments authorized shall not constitute final acceptance of the material and the Contractor shall be responsible for such materials. Payment of partial estimates for stored material, acceptance of the materials to be stored, or approval of the storage method does not relieve the Contractor's responsibility for all materials and work upon which payments have been made or the restoration of any damaged work. The payments are not a waiver by the Department of any other Contract provisions or of its rights to require fulfillment of all Contract terms.

Materials paid for by the Department are the property of the Department, but the risk of loss shall remain with the Contractor. If materials for which the Department has paid are later found to be unacceptable, then the Department may withhold amounts reflecting such unacceptable materials from payments otherwise due the Contractor.

In the event of default, the Department may use or cause to be used all paid-for materials in any manner that is in the best interest of the Department.

109.07 COMPENSATION FOR ALTERED QUANTITIES.

When the accepted quantities of work vary from the quantities in the bid schedule, the Contractor shall accept as payment in full, so far as Contract items are concerned, payment at the original Contract Unit Price for the accepted quantities of work done. No allowance except as provided in Section 104.03 will be made for any increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the Contractor, whether resulting directly from alterations in the work or indirectly from unbalanced allocation of overhead expenses among the Contract items or from any other cause.

109.08 ACCEPTANCE AND FINAL PAYMENT.

When the Project has been accepted as provided in Section 105.13, the Engineer will prepare the final estimate for work performed. After approval of the final estimate by the Contractor, the entire sum due will be paid after deducting all previous payments and all amounts owed to the Department or to be retained or deducted under the Contract provisions.

All prior partial estimates and payments shall be subject to correction in the final estimate and payment.

The Contractor may be required to furnish proof of compliance with all laws which directly or indirectly apply to the work before any partial or final payment is made.

109.09 CONVERSION TO METRIC SYSTEM.

The transportation industry is moving toward adoption of the Metric System, also known as the International System of Units (SI). AASHTO has officially endorsed such action, and uses the Metric System to establish standard sieve sizes in AASHTO M 92.

Some applicable conversion factors are as follows:

To Convert From	To	Multiply By
Inch	Metre (m)*	.0254 or 2.54×10^{-2}
Foot	Metre (m)	.3048 or 3.048×10^{-1}
Foot ²	Metre ² (m ²)	.092903040 or 9.2903040×10^{-2}
Yard ²	Metre ² (m ²)	.836127360 or $8.36127360 \times 10^{-1}$
Foot ³	Metre ³ (m ³)	.028316847 or 2.8316847×10^{-2}
Yard ³	Metre ³ (m ³)	.764554858 or $7.64554858 \times 10^{-1}$
Pound (Mass)	Kilogram	.453592370 or $4.53592370 \times 10^{-1}$
Gallon (U.S.)	Metre ³ (m ³)	.003785411784 or $3.785411784 \times 10^{-3}$
Metre	Inch	39.37007874
Metre	Foot	3.280839895
Metre ² (m ²)	Foot ²	10.76391042
Metre ² (m ²)	Yard ²	1.195990046
Metre ³ (m ³)	Foot ³	35.31466621
Metre ³ (m ³)	Yard ³	1.307950619
Kilogram	Pound (Mass)	2.204622622
Metre ³ (m ³)	Gallon (U.S.)	264.172052

Additional information and conversion factors can be found in AASHTO R1 or ASTM E 380.

*The spelling "metre" is preferred by AASHTO, although "meter" is widely used.

SECTION 110 ENVIRONMENTAL PROTECTION

110.01 DESCRIPTION.

This work consists of operational controls to be practiced and temporary pollution control measures to be taken to aid in controlling erosion and water pollution resulting from construction operations.

Temporary erosion and pollution control measures to be taken shall be those shown on the Plans, proposed by the Contractor and approved by or ordered by the Engineer during the

life of the Contract. The work shall provide prevention, control, and abatement of water pollution through the use of berms, dikes, dams, sediment basins, fiber mats, netting, gravel, mulches, grasses, slope drains, and other erosion control devices or methods.

Temporary erosion and pollution control measures shall be coordinated with permanent erosion control features specified elsewhere in the Contract to the extent practical to assure economical, effective, and continuous erosion control throughout the construction and post-construction period.

Temporary pollution control may include construction work outside the Right of Way where roadway associated construction is necessary. This includes borrow pit operations, haul roads, equipment storage sites, and plant sites.

110.02 MATERIALS.

Mulches may be hay, straw, wood cellulose, corn stalks, bark, corn cobs, wood chips, or other suitable material acceptable to the Engineer. Mulches shall be clean and free of noxious weeds and deleterious materials.

Slope drains may be constructed of pipe, fiber mats, rubble, portland cement concrete, bituminous concrete, plastic sheets, or other material acceptable to the Engineer that adequately controls erosion.

Grass shall be quick-growing species suitable to the area and should provide a temporary cover which will not later compete with grasses sown for permanent cover.

Sediment basins, sediment traps, barriers, and filters may be constructed by using staked hay or straw bales in conjunction with necessary earthwork.

110.03 PRECONSTRUCTION CONFERENCE.

The Contractor shall submit in writing, for acceptance at the preconstruction conference or before starting work on the construction, a Storm Water Pollution Prevention Plan (SWPPP). This plan shall include erosion and pollution controls on the project site, haul roads, borrow pit sites, plant sites, and the disposal of waste materials. No work shall be started until the plan for pollution control and prevention has been accepted by the Engineer.

110.04 STORM WATER PERMITS

Any project with a contiguous area of disturbance greater than 1 acre requires a North Dakota Pollution Discharge Elimination Systems (NDPDES) Construction permit. Projects that have multiple individual sites of activity will require a permit if any one of the individual sites has an area of disturbance greater than one acre.

The Contractor of each new project, meeting the criteria above, shall be required to open an NDPDES permit by completing the permit application process.

The Contractor has day to day operational control of construction and activities and is thus an operator of the project under the permit. The operator is required by the permit to adhere to the conditions of the storm water permit and storm water pollution prevention plan as it relates to controlling erosion and sedimentation during

Contracted activities, maintaining erosion control devices, conducting inspections and maintaining appropriate records. The Contractor shall be required to complete and sign a permit application as it pertains to an operator.

When the Contractor's project is finalized by the Department, the Contractor may be released from the storm water permit. If, at the time of finalization, the project meets the criteria for final stabilization the Department will file, or direct the Contractor to file, a Notice of Termination (NOT) to the North Dakota Department of Health (NDDOH). If the project does not meet the criteria for final stabilization the Department shall be considered the sole permittee for the project. Department project records shall serve as documentation for reporting the transfer of control for projects in lieu of the procedures outlined by the NDDOH for permit transfer.

110.05 OPERATIONAL CONTROLS.

- A. **Work Areas.** Where a work area is adjacent to a live stream or lake, or runoff water from the work area enters a live stream or lake, the Contractor shall erect barriers or provide sediment basins to prevent direct runoff from reaching the live stream or lake.

Material shall not be transported across a live stream by fording. A temporary bridge or crossing shall be used for this purpose.

Mechanized equipment shall not be operated in a live stream channel except to construct required crossings or barriers and fills at channel changes.

Wash water from aggregate washing or other operations shall be held in a settling basin to prevent muddy water from entering the live stream or lake.

Portland Cement, fresh Portland Cement Concrete, oily or greasy material or waste material shall not be dumped into or allowed to enter a live stream or lake.

Perform washout of concrete mixers, delivery trucks, and other delivery systems in designated areas only. Contractors will provide designated truck washout areas that will contain washout from concrete placement and construction equipment cleaning operations. These areas must be self-contained and not drainable to any storm water outlet of the site. Temporary concrete washout facilities shall be constructed above grade or below grade at the option of the Contractor and shall have a temporary pit or bermed areas of sufficient volume to completely contain all liquid and waste concrete. Temporary concrete washout facilities shall be constructed and maintained in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations. Upon completion of construction, washout areas will be properly stabilized. Payment for concrete washout facilities and associated work will not be made separately, but shall be included in the price bid for other items.

The Contractor shall be responsible for the proper disposal of all removed concrete, pavement, foundations, and other unsuitable material. The disposal site shall not be a wetland and shall be a site acceptable to the Engineer.

Compliance with these controls shall not relieve the Contractor of the responsibility to comply with other provisions of the Contract, nor the responsibility for damage and preservation of property.

110.06 EROSION CONTROLS.

The Engineer has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and fill operations; and to direct the immediate installation of permanent or temporary pollution control measures to prevent contamination of adjacent streams, watercourses, lakes, ponds, or other areas of water impoundment. Such work may involve construction of temporary berms, dikes, dams, sediment basins, slope drains, and use of temporary mulches, mats, seeding, or other control devices or methods as necessary to control erosion. Embankment and cut slopes shall be seeded and mulched as excavation proceeds to the extent considered desirable and practicable.

The Contractor shall incorporate all permanent erosion control features into the Project at the earliest practical time as outlined in the accepted Plan. Temporary pollution control measures shall be used to correct conditions that develop during construction, that are needed before installing permanent pollution control features, or that are needed temporarily to control erosion during construction. These temporary measures are not associated with permanent control features on the Project.

Clearing and grubbing operations shall be scheduled and performed so grading operations and permanent erosion control features can follow immediately if Project conditions permit; otherwise temporary erosion control measures may be required between successive construction stages.

The extent of clearing and grubbing operations and the excavation, borrow, and embankment operations for two-lane construction shall not cover a distance of more than 3 miles. No work shall start in the fourth mile until necessary erosion and pollution control measures are completed in the first mile.

The extent of clearing and grubbing operations and the excavation, borrow, and embankment operations on four-lane construction shall cover a distance of not more than 2 miles. No work shall start in the third mile until necessary erosion and pollution control measures have been started in the first mile.

On grade widening and selective grading Projects, the Engineer will limit the extent of clearing and grubbing, excavation, borrow, and embankment operations in progress commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding, and other such permanent erosion and pollution control measures current. Construction operations shall be limited to 5 miles until erosion and pollution control measures have been started in the first mile.

When a suspension of work is ordered or when operations on the Project are suspended for the winter, the Contractor shall take all action necessary to control erosion, pollution, and runoff during the shutdown period before the Department accepts responsibility for maintenance.

110.07 METHOD OF MEASUREMENT AND PAYMENT.

- A. When temporary erosion and pollution control measures are required due to Contractor's negligence, carelessness, or failure to install permanent controls as part of the scheduled work and are ordered by the Engineer, the work will not be measured for payment and shall be done by and at the Contractor's expense.

- B. Temporary erosion and pollution control work required, but not due to the Contractor's negligence, carelessness, or failure to install permanent controls, shall be performed as ordered by the Engineer. Work items required for this control work that have a Contract price shall be measured as provided by the Specifications for that item of work.
- C. Should the Contractor fail to control erosion, pollution, and siltation, the Engineer will employ outside assistance or State forces to do the work. The direct costs, overhead costs, and engineering costs incurred under these conditions will be deducted from payments due the Contractor for work done on the Contract.

**SECTION 150
EQUIPMENT**

SECTION 151 GENERAL EQUIPMENT

151.01 GENERAL

151.02 ROLLERS

- A. Tow-Type Pneumatic-Tired Rollers
- B. Self-Propelled Pneumatic-Tired Rollers
- C. Smooth-Faced Steel-Wheel Rollers
 - 1. General
 - 2. Smooth-Faced Steel-Wheel Roller: Tandem - Type A
 - 3. Smooth-Faced Steel-Wheel Roller: Tandem - Type B
- D. Vibratory Rollers
- E. Combination Rollers
- F. Vibratory Sheep Foot/Pad Foot/Extended Pad Foot Rollers

151.03 HAULING EQUIPMENT

- A. Water-Hauling Equipment
- B. Material-Hauling Equipment

151.04 BITUMINOUS PAVERS

151.05 LIQUID BITUMEN DISTRIBUTORS

151.06 AGGREGATE SPREADER

151.07 SCALES

- A. General
- B. Truck Scales
 - 1. General
 - 2. Installation and Maintenance
 - 3. Platform and Approaches
 - 4. Scale Tests
 - a. Zero Load Test
 - b. Comparison Test
 - c. Sensitivity Test
 - d. Shift Test
- C. Electronic Truck and Hopper Scales
 - 1. Electronic Weigh System
 - 2. Randomly Checked Weighing
 - 3. Electronic Truck Scales
 - 4. Hopper Scale Tests
 - a. Sensitivity Test
 - b. Comparison Test
- D. Full Length Electronic Platform Scales and Hopper Scales
 - 1. Minimum Tonnage
 - 2. Digital Readouts
- E. Belt Scales
 - 1. General
 - 2. Comparison Test
 - 3. Randomly Checked Weighing
 - 4. Weigh Tickets
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 - 1. General
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 - 3. Randomly Check Weighing

- 4. Weigh Tickets
 - G. Contractor Furnished Scale, Scale Person and Dump Person
 - 1. General
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- 151.08 MINING/BLENDING MACHINE

SECTION 152 HOT BITUMINOUS EQUIPMENT

- 152.01 REQUIREMENTS FOR ALL MIXING PLANTS
- A. General
 - B. Storage and Heating Equipment
 - C. Feeders
 - D. Drier
 - E. Thermometric Equipment
 - F. Flow Rate Meter
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- 152.02 SAMPLING DEVICES FOR MIXING PLANTS
- 152.03 SPECIAL REQUIREMENTS FOR BATCH MIX PLANTS AND FOR CONTINUOUS MIX PLANTS
- 152.04 SPECIAL REQUIREMENTS FOR DRUM-DRYER MIXING PLANTS
- A. General
 - B. Surge Bins
- 152.05 MILLING MACHINE
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SECTION 153 PORTLAND CEMENT CONCRETE EQUIPMENT

- 153.01 BATCHING AND WEIGHING EQUIPMENT
- A. General
 - B. Automatic Batching Equipment
- 153.02 MIXERS
- A. Stationary Mixers
 - B. Truck Mixers
 - C. Mobile Mixers
- 153.03 CONCRETE TRANSPORTING EQUIPMENT
- A. General
 - B. Agitators
- 153.04 SIDE FORMS
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- 153.06 ROADBED PLANERS
- 153.07 CONCRETE SPREADERS
- 153.08 VIBRATORS
- 153.09 CONCRETE FINISHING MACHINES
 - A. Transverse Finishing Machines for PCC Pavement
 - B. Bridge Deck Finishing Machines
 - C. Finishing Machines for Bridge Deck Overlays
- 153.10 HAND FINISHING EQUIPMENT
 - A. Screeds
 - B. Straightedges
- 153.11 SPRAYERS FOR LIQUID CURING COMPOUND
- 153.12 CONCRETE SAWS
- 153.13 JOINT AND CRACK CLEANING AND SEALING EQUIPMENT
 - A. General
 - B. Hot Poured Joint Sealant
 - C. Silicone Sealant
- 153.14 PREFORMED ELASTOMERIC COMPRESSION JOINT SEAL EQUIPMENT
- 153.15 GRINDING MACHINE
- 153.16 HYDRODEMOLITION EQUIPMENT

SECTION 151 GENERAL EQUIPMENT

151.01 GENERAL.

Equipment used on the work shall be of sufficient size and mechanical condition to produce a product of specified quality. The Engineer may order the removal, replacement, or repair of any equipment that produces non-specification work.

The Contractor may request, in writing, permission to use alternative and innovative equipment and shall furnish evidence that the proposed equipment produces work equal to the quality produced with specified equipment.

If permission is granted, permission may be withdrawn if the results are not satisfactory. Any defective or unsatisfactory work produced shall be removed and replaced or corrected at the Contractor's expense.

No additional compensation will be allowed for any delays or additional costs incurred as a result of applying this provision.

151.02 ROLLERS.

- A. **Tow-Type Pneumatic-Tired Rollers.** The roller shall be equipped with at least seven wheels with pneumatic tires of equal size and ply.

The wheels shall be arranged to provide complete coverage of the area the roller travels.

The empty and ballasted weights shall be determined from the manufacturer's rating, provided the roller has not been modified from its original design and the ballast furnished is of known weight. If the roller has been modified or if the ballast is not of known weight, the Contractor shall provide a suitable scale for weighing the roller.

Tires shall be uniformly inflated so their air pressure will not vary by more than 5 psi. Rollers shall be operated with tire inflation pressures and wheel loads within the manufacturer's recommended range for the size and ply of tire being used. Rollers shall be constructed so they can be loaded to a gross weight of at least 225 pounds per inch of compaction width.

The tow-type rollers shall not be used to compact paver laid asphalt cement surfaces except for incidental patching.

- B. **Self-Propelled Pneumatic-Tired Rollers.** The roller shall be equipped with at least seven wheels with pneumatic tires of equal size and ply.

The wheels shall be arranged to provide complete coverage of the area the roller travels.

Rollers shall start, stop, and reverse direction smoothly, without jerking or backlash, and shall be equipped with positive, accurate steering control.

To prevent pickup on asphalt pavement, the roller shall be equipped with smooth-tread tires, close-fitting scrapers for each wheel, and a system for uniformly moistening each wheel without excessive use of water and detergent. Petroleum products shall not be used for moistening the wheels. The roller shall be equipped with skirting of sufficient size to retain heat on the tires. "Wobble-wheel" rollers shall not be used.

The empty and ballasted weights shall be determined from the manufacturer's rating, provided the roller has not been modified from its original design and the ballast furnished for the roller is of known weight. If the roller has been modified or if the ballast is not of known weight, the Contractor shall provide a suitable scale for weighing the roller.

The tires shall be uniformly inflated so their air pressure does not vary by more than 5 psi. The roller shall be constructed so the contact pressure may be varied between 40 psi and 90 psi. The contact pressure shall be defined as the "average ground contact pressure," expressed in psi, obtained when the wheel load in pounds is divided by the gross contact area in square inches of the tire. The Contractor shall furnish any data necessary to determine the contact pressures for the full range of the manufacturer's recommended wheel loads and tire inflation pressures.

C. Smooth-Faced Steel-Wheel Roller.

1. **General.** All smooth-faced steel-wheel rollers shall be self propelled and capable of starting, stopping, and reversing direction smoothly, without jerking or backlash. The roller shall be equipped with positive, accurate steering control. The face of all rollers shall be smooth and free from defects which will mar the surface of the material being compacted. Each wheel or roller shall be equipped with adjustable spring scrapers, and a system for uniformly moistening the full width of each roll or wheel without use of excess water.
2. **Smooth-Faced Steel-Wheel Roller: Tandem - Type A.** This roller shall meet Section 151.02 C.1 and the following requirements:

The empty and ballasted weights shall be determined from the manufacturer's rating, provided the roller has not been modified from its original design and the ballast furnished is of known weight. If the roller has been modified or if the ballast is not of known weight, the Contractor shall provide a suitable scale for weighing the roller.

The roller shall be of a two-axle or three-axle tandem design and when fully ballasted shall have a gross weight of 10 tons or more.

3. **Smooth-Faced Steel-Wheel Roller: Tandem - Type B.** This roller shall meet Section 151.02 C.2 except that when fully ballasted it shall have a gross weight of 8 tons or more with no specified contact pressure.

- D. **Vibratory Rollers.** Vibratory rollers shall be of sufficient size and number to keep up with roadway production and provide the specified density.

Vibratory rollers for use on rock embankments, granular borrow, and bases shall meet speed and frequency ranges (vibrations per minute) shown in Table 151-1. Rollers should be operated at high amplitude unless otherwise directed and the roller speed and the vibrations per minute coordinated so there is a minimum of 6 impacts per linear foot.

**TABLE 151-1
AGGREGATE BASE AND EARTHWORK
Impacts per Linear Foot**

Roller Speed M.P.H. (ft./min.)	(Vibrations per Minute)							
	1000	1200	1400	1600	1800	2000	2200	2400
1.0 (88)	11.31	13.6	15.9	18.1	20.4	22.7	25.0	27.2
1.5 (132)	7.6	9.1	10.6	12.1	13.6	15.2	16.7	18.2
2.0 (176)	-	6.8	8.0	9.1	10.2	11.4	12.5	13.6
2.5 (220)	-	-	6.4	7.3	8.2	9.1	10.0	10.9
3.0 (264)	-	-	-	6.1	6.8	7.6	8.3	9.1
3.5 (308)	-	-	-	-	5.8	6.5	7.1	7.8
4.0 (352)	-	-	-	-	-	-	6.3	6.8
4.5 (396)	-	-	-	-	-	-	-	6.1

Vibratory rollers used on plant mix base and hot bituminous pavement shall be operated at the speed (mph) and frequency ranges to provide a minimum of 10 impacts per linear foot as shown in Table 151-2. Rollers shall be amplitude adjustable and operated at low amplitude unless otherwise directed. Only drum-type rollers will be permitted meeting the following minimum requirements: 1800 vibrations per minute (VPM), static force on drums of 135 pounds per linear inch (PLI) of roller width, and total applied force on vibrating drums (dynamic plus static) of 300 pounds per linear inch (PLI).

Rollers shall be self propelled, and equipped with spray bars to prevent pickup of asphalt material. Vibrators shall shut off automatically whenever the roller stops. Rollers shall be capable of being operated as a static roller.

Vibratory rollers shall be equipped with an accurate and working gauge or gauges for measuring the frequency of each drum or the Contractor shall provide the Engineer with an accurate hand-held resonant reed tachometer for each roller before using the roller on the Project. If the frequency gauge malfunctions or the tachometer is damaged, the Contractor shall have 48 hours to repair or replace it or the roller cannot be used on the Project.

Full instructions on the procedures of making amplitude adjustments shall accompany each roller.

**TABLE 151-2
ASPHALT PAVING
Impacts per Linear Foot**

Roller Speed M.P.H. (ft./min.)	(Vibrations per Minute)						
	1800	2000	2200	2400	2600	2800	3000
1.0 (88)	20.4	22.7	25.0	27.2	29.5	31.8	34.1
1.5 (132)	13.6	15.2	16.7	18.2	19.7	21.2	22.7
2.0 (176)	10.2	11.4	12.5	13.6	14.8	15.9	17.0
2.5 (220)	-	-	10.0	10.9	11.8	12.7	13.6
3.0 (264)	-	-	-	-	-	10.9	11.4

When the roller is in the static mode and prior to achieving required density, the traveling speed shall not exceed 4 mph.

- E. **Combination Rollers.** Combination Rollers shall meet the requirements of Section 151.02 D, except they shall have a single vibrating drum in the front and four smooth pneumatic tires in the rear. The roller shall have a gross weight of 20 tons or more.

The tires shall be of equal size and ply and shall be uniformly inflated so the air pressure of each tire does not vary by more than 5 psi. The contact pressure of the tires shall be as defined in Section 151.02 B.

- F. **Vibratory Sheep Foot/Pad Foot/Extended Pad Foot Rollers.** Vibratory sheep foot/pad foot/extended pad foot rollers shall be capable of developing centrifugal force of 50,000 pounds or more, have a minimum operating weight of 23,000 pounds, and a minimum roller width of 6 feet.

151.03 HAULING EQUIPMENT.

- A. **Water-Hauling Equipment.** Water hauling units shall be equipped with a spraying device capable of evenly distributing water over the designated area. The water tank and all connections shall be watertight.
- B. **Material-Hauling Equipment.** The hauling vehicles shall have a dump box capable of controlled discharge onto the roadbed or into pavers. The dump box shall be constructed and maintained so material is not lost during transit.

Bituminous mixture haul trucks shall be equipped with a smooth-lined dump box, free from cracks, holes, or deep dents. The truck frame or dump body shall not make direct contact with the paver, and the truck or box shall not exert pressure on the paver during dumping operations. The dump box shall be lubricated when necessary with a thin film of material that does not dissolve the bitumen. Before use, excess coating shall be drained out of the box. Petroleum distillates such as kerosene or fuel oil will not be permitted.

A hole of sufficient diameter to receive the thermometer shall be provided on the driver's side of the truck box at the approximate intersection of imaginary diagonal lines drawn from the corners of the truck box.

Each truck shall be equipped with a cover made of canvas or other suitable material of adequate size to protect the hot mix from the weather.

151.04 BITUMINOUS PAVERS.

Self-propelled pavers shall be provided with a full width vibrating screed, heated if necessary, and capable of spreading and finishing the mix in lane widths to the specified typical section and thicknesses shown on the Plans. Hydraulic extendable screeds may be used for variable width pavements. The paver shall have an auger that extends to within one foot from either edge of the vibrating screed. Pavers used for shoulders and similar construction shall spread and finish the mix in widths shown on the Plans.

The paver's receiving hopper shall have sufficient capacity for a uniform spreading operation and with a distribution system that places the mixture uniformly in front of the screed.

The screed or strike-off assembly shall produce the specified finished surface without tearing, shoving, or gouging the mixture.

The paver shall operate at speeds consistent with continuous and uniform laying of the mixture.

The control system shall automatically control the elevation and transverse slope of the paver screed. A 30-foot minimum length rolling straightedge, erected stringline, or other approved device shall be used to establish the grade reference for control of the screed height. The tension in the stringline shall be adequate to prevent deflection due to the weight of the grade sensor. The system shall permit the grade reference device to operate on either side of the paver, and shall maintain the desired transverse slope regardless of changes in screed elevation. The system shall be capable of conversion to manual control of the screed slope and elevation. Whenever breakdown or malfunction of the automatic screed controls occurs, the equipment may be operated manually for the remainder of that working day, provided the finished product meets Specifications. Frequent or prolonged breakdown shall constitute cause for work suspension until satisfactory repairs or replacements are made.

151.05 LIQUID BITUMEN DISTRIBUTORS.

Distributors shall be mounted on a truck capable of maintaining uniform speeds for proper application of the bitumen.

The distributor shall apply the bitumen uniformly on the designated area, at the specified rate, within a tolerance of 0.02 gallon per square yard.

The truck shall be equipped with a tachometer, visible to the driver, which accurately registers the truck speed in feet per minute. The tachometer shall be operated by a wheel independent of the truck wheels.

The distributor shall be equipped with a circulating heating system that evenly controls the heating of the bitumen to the specified temperature. The tank shall be equipped with a visible thermometer that accurately registers the temperature of the contents.

The distributor pressure pump shall be capable of maintaining a uniform and sufficient pressure throughout the full length of the spray bar during operation. A gauge shall be provided which shows the pump output in gallons per minute.

The distributor shall be equipped with full-circulation spray bars designed to permit any adjustments necessary to obtain uniform, complete distribution of bitumen on the designated area. The flow of bitumen through the spray nozzles shall be controlled by cutoff valves to start and stop the flow quickly and uniformly over the length of spray bar without dripping. The Contractor shall provide data showing the manufacturer's instructions or recommendations for spray bar height above the road surface, nozzle size, and angle of spray fan with the spray-bar axis.

A workable gauge shall be visibly located on the distributor tank for determining the quantity of material in the tank at any time. The Engineer may require that the distributor be calibrated at any time. All necessary means and assistance for calibrating the distributor shall be provided by the Contractor.

For each distributor, the Contractor shall provide charts, tables, or other means for accurate, rapid determination of application rates in gallons per square yard for various spray bar widths, truck speeds, and pump pressure, or output.

151.06 AGGREGATE SPREADER.

The aggregate spreader shall deposit the designated quantity of aggregate per square yard in a smooth, uniform layer on the freshly deposited bitumen so the equipment wheels do not contact any bitumen not covered by aggregate. The rate of aggregate discharge shall be uniform over the full application width, and whenever necessary, cutoff plates shall be provided to reduce the width of spread in suitable increments to meet job requirements.

The application width of the spreader shall be adequate to cover the full width of one traffic lane plus one foot; however, the application width will not be required to exceed 13 feet.

151.07 SCALES

- A. **General.** The Contractor shall have the scale tested and certified by the Weights and Measures Division of the Public Service Commission or a certified scale service within 6 months prior to use on the Project. Before beginning the weighing operation, the Engineer shall test the scale, and if the scale is not within the required tolerance, the Engineer may serve written notice to have the scale retested by an approved agency before allowing it to be used on the Project.

The Contractor shall bear all expenses for having scales tested and certified by the Weights and Measures Division of the Public Service Commission or a certified scale service, and for making weight comparisons with other scales.

The scale shall not be altered from the manufacturer's original design unless alterations are approved by the Weights and Measures Division of the Public Service Commission or a certified scale service, and specifically shall not be altered to weigh loads in excess of the rated capacity of the scale.

The Contractor shall provide 100 pounds of test weights in units of 50 pounds each. Weights shall be made of metal not easily altered in size or weight. Each

weight shall be certified as to weight by the Weights and Measures Division of the Public Service Commission or a certified scale service, and stamped or permanently marked with its certified weight.

Scale persons may not be provided by the Department when electronic scales with automatic printers are used.

The Contractor is responsible for meeting the legal load limits established by law.

B. **Truck Scales.**

1. **General.** For each truck scale, the Contractor shall furnish a weather tight building equipped with light, heat, air conditioning, and a chair or stool for the scale operator's use. The building shall enclose the recording beams of the scale.
2. **Installation and Maintenance.** The scale shall be installed on a firm, level foundation. All working parts shall be installed and maintained in correct position with respect to level and vertical alignment. Adequate clearance shall be maintained around all working parts. Knife-edge pivots shall be sharp and straight, and pivot-bearing surfaces shall be smooth. The scale shall be cleaned as necessary for the proper functioning and accuracy. The Contractor is responsible for keeping the scale platform clean.
3. **Platform and Approaches.** The scale shall have a platform of adequate length to weigh the longest truck or truck-trailer combination in one operation or,
 - a. The truck or truck-trailer combination shall be weighed on separate scales whose platforms are at the same elevation and arranged to permit simultaneous weighing of the entire unit, or,
 - b. The wheel loads of the truck or truck-trailer combination may be weighed in separate operations provided any wheels not resting on the scale platform are supported on a concrete or asphalt paved level approach or on an independent level platform rigidly constructed of wood or steel.
4. **Scale Tests.** The Contractor shall maintain the scale balance and conduct the testing as the Engineer deems necessary to insure that the scale accuracy is within the Specifications. If the scale does not meet the tolerances specified below, use of the scale shall be discontinued until the scale is repaired and is within the specified tolerances. The scale shall meet the following:
 - a. **Zero Load Test.** When no load is on the scale and all beam weights are set at zero, the scale shall be adjusted to balance or to read zero.
 - b. **Comparison Test.** The scale shall be maintained within plus or minus 1 percent of the correct weight of the applied load. A minimum of one comparison test is required for every 5,000 tons of material weighed or one day's production, whichever is greater. The comparison test can be made by one of the following methods:
 - (1) A loaded truck, which has been weighed on the Contractor's scale will be randomly selected by Department personnel at a random time and weighed on another certified scale.

- (2) A piece of equipment that has been certified as to weight shall be weighed on the Project scale. The piece of equipment shall weigh at least 60 percent of the maximum weight which will be applied to the scale for the Project. The certified weight shall be initially determined at the time the scale is certified and rechecked each time the scale is recertified. The piece of equipment shall have a plate showing the certified weight welded to it. The piece of equipment shall be clean of mud and dirt and shall be refueled each time it is used for the weight comparison. Recertification will be required when any changes, such as wheel weights and ballast are made that will affect the certified weight.

When a piece of equipment with a certified weight is used to make scale checks, weight comparisons are to be made with another certified scale for the first 2 days of operation and once a month thereafter.

Any weight comparisons that do not meet Specifications (plus or minus 1 percent of the applied load) will be rechecked after adjustments are made.

- c. **Sensitivity Test.** A weekly sensitivity test shall be made by adding 100 pounds of test weights to the scale after a loaded truck is on the scale and the load has been weighed. If the scale is not sensitive to the added weight, the scale shall not be used on the Project until it has been repaired.
- d. **Shift Test.** The scale shall weigh within the required accuracy regardless of the position of the load on the scale platform. The performance of the scale with off-center loading shall be checked by comparing the results obtained by weighing a loaded truck with: (1) the rear wheels at the extreme end of the scale platform; (2) the position of the truck is then reversed with the rear wheels at the extreme opposite end of the platform; and (3) the truck is centered on the scale platform.

This test shall be performed at the beginning of the Project and at least one other time during the Project. Weight differences shall not be greater than 0.2 percent of one another.

C. **Electronic Truck and Hopper Scales.**

1. **Electronic Weigh System.** The electronic digital weigh station shall use a load cell or cells. All scales shall conform to the current edition of the National Bureau of Standards Handbook 44. The weight indicated shall be accurate to within 1.0 percent of the true weight.

The system shall include an automatic printer that provides the following minimum information:

- | | |
|--------------------------------|-------------------------|
| a. Project Number (numerical) | f. Gross Weight |
| b. Date | g. Tare Weight |
| c. Time | h. Net Tons in the Load |
| d. Ticket Number (consecutive) | i. Product Designation |
| e. Haul Unit Number | |

Items f and g will not be needed if the material is weighed in a hopper scale.

The printer shall produce a minimum of two copies of each ticket with a maximum size of 5-1/2 × 8-1/2 inches, and the words and numerals shall be clear and legible.

The printer and the control shall be programmed or otherwise equipped to print a word or symbol identifying when any weight information is manually entered.

If the printer or control malfunctions, manual weighing and recording as specified in Section 151.07 B will be permitted. Also, in the event of a printer or control malfunction, material that is in storage or in a surge bin may be delivered to the roadway, if the weight of the material can be accurately established.

2. **Randomly Checked Weighing.** When a Department scaleperson is not used, the Engineer shall validate the truck and/or material weight by randomly reweighing the truck. The Engineer shall randomly select a minimum of one loaded truck for each 5,000 tons of material weighed or one day's production, whichever is greater, to validate the weight. The weight check must be done on a certified scale.

Should the random weight checks disclose weight differences of more than 1 percent using the comparison test, the scale shall be retested and adjusted as necessary to assure accurate weighing.

3. **Electronic Truck Scales.** Electronic truck scales shall meet Sections 151.07 A and 151.07 B.
4. **Hopper Scale Tests.**

- a. **Sensitivity Test.** A weekly sensitivity test shall be made by adding 100 pounds of test weights after the hopper scale is loaded and weighed. If the scale is not sensitive to the added weight, the scale shall not be used on the Project until it has been repaired.
- b. **Comparison Test.** The scale shall be maintained within plus or minus 1 percent of the correct weight of the applied load. One comparison test is required for every 5,000 ton of material weighed or one day's production, whichever is greater. The test shall be made by comparing the weight of the material in the hopper and the weight of the material after it is weighed on another certified scale.

D. **Full Length Electronic Platform Scales and Hopper Scales.** The Full Length Electronic Platform Scale (FLEPS) shall be equipped with a platform of sufficient length that the longest hauling unit can be weighed in one operation. Split weighing will not be allowed.

1. **Minimum Tonnage.** The Contractor shall furnish a Full Length Electronic Platform Scale or an Electronic Hopper Scale on any Contract that contains at least one pay item whose quantity must be determined by weighing, and the estimated quantity of that pay item is 50,000 tons or more. The Contractor may use other approved scales to weigh pay items of lesser tonnage.

2. **Digital Readouts.** Each FLEPS and Hopper Scale shall be equipped with an electronic digital readout which displays the tonnage being weighed and will operate continually during weighing operations.

E. Belt Scales.

1. **General.** Belt conveyor scales shall comply with the requirements for Belt-Conveyor Scales in the current edition of the National Bureau of Standards Handbook No. 44. The weight indicated shall be accurate to within 1.0 percent of the true weight.
2. **Comparison Test.** At the beginning of each day, the Contractor shall weigh five or more loads from sequential hauling units and compare the total weight with the total weight of the same loads taken on a platform scale meeting specification requirements. The belt scale shall be maintained within plus or minus 1 percent of the platform scale.
3. **Randomly Checked Weighing.** The Engineer will randomly select a minimum of one loaded truck for every 1,000 tons of material weighed or one day's production, whichever is less, to validate the weight. The weight check must be done on a certified scale.

Should random weight checks disclose weight differences of more than 1.0 percent, the scale shall be retested using the comparison test and adjusted as necessary to assure accurate weighing within 1 percent.

If testing shows the scale has been under-weighing, it shall be adjusted immediately. The Contractor shall not be compensated for any loss from under-weighing.

If the scale has been over-weighing, its operation shall cease immediately until adjusted. The Engineer will determine the weight of all material weighed after the last comparison test meeting the specified requirements. This weight will be reduced by the percentage of scale error that exceeds one percent to determine the pay quantity.

4. **Weigh Tickets.** The Contractor shall provide two copies of weigh tickets that provide the following minimum information:
 - a. Project Number
 - b. Date
 - c. Time
 - d. Ticket Number (Consecutive)
 - e. Hauling Unit Number
 - f. Net tons in the load
 - g. Pit Location
 - h. Type of Material

The tickets and weighing procedures shall be approved by the Engineer.

F. Loader Bucket Scales.

1. **General.** Loader bucket scales shall use a load cell or cells. All scales shall conform to the current edition of the National Bureau of Standards Handbook 44. The weight indicated shall be accurate to within 1.0 percent of the true weight.

2. **Comparison Test.** At the beginning of the first day of production, the Contractor shall weigh three or more loads from sequential hauling units and compare the total weight with the total weight of the same loads taken on a platform scale meeting specification requirements. Load the trucks using the loader scale in dynamic mode. The loading area shall be level. Operation of the loader scale shall be as recommended by the manufacturer for accurate weighing. The weight obtained from the loader bucket scale shall be within plus or minus 1.0 percent of the platform scale.
3. **Randomly Checked Weighing.** The Engineer will randomly select a minimum of one loaded truck for each day's production to validate the weight. The weight check must be done on a certified scale.

Should random weight checks disclose weight differences of more than 1.0 percent, the scale shall be retested using the comparison test and adjusted as necessary to assure accurate weighing within 1.0 percent.

If testing shows the scale has been under-weighing, it shall be adjusted immediately. The Contractor shall not be compensated for any loss from under-weighing.

If the scale has been over-weighing, its operation shall cease immediately until adjusted. The Engineer will determine the weight of all material weighed after the last comparison test meeting the specified requirements. This weight will be reduced by the percentage of scale error that exceeds one percent to determine the pay quantity.

Any time during production the Engineer may require the loader bucket scale to be checked for accuracy.

4. **Weigh Tickets.** The computerized scale system shall include an automatic printer that prints two weigh tickets to be provided to the Engineer containing the following minimum information:
 - a. Project Number
 - b. Date
 - c. Time
 - d. Ticket Number (Consecutive)
 - e. Hauling Unit Number
 - f. Net tons in the load
 - g. Pit Location (by legal description)
 - h. Type of Material

The tickets and weighing procedures shall be approved by the Engineer.

G. Contractor Furnished Scale, Scale Person and Dump Person.

1. **General.** If specified on the Plans, this work shall consist of providing a scale, scale person, and dump person for proper construction of the Project.
2. **Construction Requirements.** The Contractor shall furnish and use a full length electronic truck scale meeting the requirements of Section 151.07 of the Standard Specifications and the following requirements for weighing all Aggregate Base or specified materials on the Project.

The electronic truck scale system shall include an automatic printer for haul tickets and haul sheets.

The computerized scale system shall include an automatic printer that prints a haul ticket containing the following information:

- | | |
|---------------------|-----------------------------|
| a. Project Number | g. Ticket Number |
| b. Time | h. Gross Weight |
| c. Haul Unit Number | i. Net Weight (in tons) |
| d. Tare Weight | j. Material Spread Distance |
| e. Type of Material | k. Pit Location |
| f. Date | |

The system shall also print a daily haul sheet containing the following information:

- | | |
|---------------------|----------------------|
| a. Date | g. Material Hauled |
| b. Project | h. Running Total |
| c. Contractor | i. Haul Sheet Number |
| d. Haul Sheet Total | j. Pit Location |
| e. Type of Project | k. Subcontractor |
| f. County | l. Pit Owner |

The haul sheet shall list each truck number and the net tons for each load hauled and total tons hauled for each unit. A haul sheet shall be made for each type of material.

The haul sheet shall also include a certified statement stating that this is a true and accurate quantity of material supplied to the Project and a line for the Contractor's signature. The haul sheet shall be signed by the Contractor and submitted to the Engineer at the end of each day. The haul sheet shall contain a blank line for the Engineer's signature.

In the case of computer malfunction, manual weighing will not be allowed for more than two consecutive work days.

The automated scale system shall be programmed so that when an overweight load is on the scale, a ticket will not be printed. An overweight load is defined as any load that is 1,000 pounds over the Legal Gross Vehicle Weight. An overload message with the gross vehicle weight shall be displayed so the overload amount is known.

The Contractor shall also provide a scale person and a person to control the contractor's dumping operation. The scale person shall operate the computerized scale system and provide each truck driver with a scale ticket for each load. The scale person shall check and record the tare weights of each hauling unit on a daily basis and provide a daily tare weight report to the Engineer. The scale person shall, under the observation of the Engineer, conduct scale tests as indicated in Section 151.07 B.4 a, c, and d of the Standard Specifications to insure the scale is operating within specification tolerances. The Engineer will conduct test item b. Comparison Test by randomly selecting a loaded truck, already weighed, for the scale check. All scale checks shall be documented and given to the Engineer with the daily tare weight report.

If a weight comparison check shows the scale under-weighing, it shall be adjusted immediately. The Contractor shall not be compensated for any loss from under-weighing.

If the scale has been over-weighing, (greater than the 1.0 percent limitation), operations will cease immediately until adjusted. The Engineer will calculate the combined weight of all material weighed after the last test showing accurate results. This combined weight will be reduced by the percentage of scale error. The Contractor's payment for this material will then be calculated using the bid price times the reduced combined weight.

The dump person shall control the Contractor's truck-dumping operations to insure proper material placement.

3. **Basis of Payment.** All costs to provide a full length electronic scale, scale person, dump person, haul tickets, and haul sheets shall be included in the bid price for the item being hauled.

151.08 MINING/BLENDING MACHINE.

The mining/blending machine shall be a self-propelled machine designed to pulverize the existing asphalt layers to a specified maximum size. It shall be capable of uniformly blending the pulverized material with existing or added aggregate base material. The machine shall have a control system to automatically control the elevation of the cutting head and be heavy enough to mine and blend the material to the specified depth.

SECTION 152 HOT BITUMINOUS EQUIPMENT

152.01 REQUIREMENTS FOR ALL MIXING PLANTS.

- A. **General.** Intermingling of aggregate sizes shall be prevented by providing adequate space between stockpiles. Various plant units shall be designed and coordinated to permit uniform, uninterrupted production under normal operating conditions and shall be capable of accurately calibrating and checking the proportions of each ingredient used in the mixture.
- B. **Storage and Heating Equipment.** Storage tanks shall uniformly heat the bitumen to the required temperature range, without damaging or changing its characteristics. Direct flame against the storage tanks will not be permitted. The tank shall be equipped with a thermometer that accurately registers the temperature of the bitumen. The Contractor shall provide measuring sticks and outage tables for accurately calibrating the tanks and checking the quantity of material in the tanks at any time. Bitumen storage or supply facilities shall adequately supply material so the plant can operate at full capacity without interruption.

- C. **Feeders.** The plant shall have an accurate mechanical means for feeding aggregates into the drier so uniform production and temperature is obtained.
- D. **Drier.** The plant shall include one or more driers which continuously agitates, heats, and dries the aggregates as specified.
- E. **Thermometric Equipment.** Temperature recording equipment shall be furnished that automatically and continuously records the mix temperature as it is discharged from the plant. The equipment shall record temperature variations of 20°F. within one minute of the time the variation occurs. The mechanism shall be accessible; have a transparent, dust-proof cover; and be located where it is unaffected by plant vibration. The mix temperature of each day's production shall be automatically recorded on a chart or charts suitably graduated to permit determination of time within 15 minutes and temperature within 10°F. The charts shall be submitted to the Engineer daily.
- F. **Flow Rate Meter.** The quantity of asphalt cement being discharged into the mixer shall be measured by a flow rate meter with totalizer, permanent recorder, and temperature compensation capabilities. The totalizer shall have the capacity of recording 1,000,000 gallons with a certified accuracy of ± 0.20 percent. The flow rate meter and totalizer shall be temperature-corrected automatically to 60°F. within an operational range of 60° to 450°F.

The flow rate meter shall continuously display and permanently record on a chart or printout the asphalt percentage of the total mix on a time-coordinated basis. The maximum chart increments shall be 0.10 percent of the total mix. If the flow varies by more than ± 0.25 percentage points from the set percentage of asphalt, the Contractor shall correct the oil variance. The Contractor shall have 1/2 hour after the first start up of the day and five minutes after any additional start up to adjust the plant to meet the tolerance. The recorder shall be accessible to the Engineer at all times, and the record of each day's operation shall be submitted daily to the Engineer.

The Contractor shall calibrate the flow meter for accuracy before the start of each Project and as necessary during the course of the Project to assure the specified accuracy. The Contractor shall make available to the Engineer a copy of the operations manual of the flow meter.

- G. **Emission Control.** Scrubbers or similar devices shall be used to meet pollution standards. Liquids from a wet scrubber shall not be discharged into a live stream, lake, or pond. The effluent shall be circulated through sludge pits or tanks. The resultant sedimentation, together with all other waste material developed by crushing and mixing operations, shall be contained or otherwise acceptably disposed of.
- H. **Cold-Feed Control.** When aggregate is handled by cold-feed control, all plant screens are removed with the exception of a scalping screen used to prevent oversize rock from entering the mix. The scalping screen's opening size shall not exceed the mix's maximum size aggregate plus 1/2 inch. A mechanical feeder having a separate bin for each aggregate to be blended in the mixture shall be provided. Each bin shall be equipped with dividers to prevent overflow of aggregate to adjacent bins, and shall have a separate and positive feed control that can be easily and accurately calibrated. The feed shall be quick-adjusting, and shall

maintain a constant and uniform flow of aggregate throughout the range of its calibration.

152.02 SAMPLING DEVICES FOR MIXING PLANTS.

The plant shall be equipped for readily obtaining a representative sample of each size of aggregate, or of the combined aggregate before the aggregate enters the mixing unit.

The Engineer shall have the right to obtain an aggregate sample at any time during the mixing operation. The Contractor may stop the belt entering the mixing plant to allow the inspector to remove a sample or provide a sampling device that is easily operated by the inspector without interrupting the mixing plant operation.

The sampling device shall be approved by the Engineer before the mixing plant is approved for use on the Project.

152.03 SPECIAL REQUIREMENTS FOR BATCH MIX PLANTS AND FOR CONTINUOUS MIX PLANTS.

The batch-type hot mix plant and the continuous type hot mix plant shall meet Section 152.01 of these Specifications except Section 152.01 F., and shall meet Section 152.02 of these Specifications and the requirements of AASHTO M 156.

152.04 SPECIAL REQUIREMENTS FOR DRUM-DRYER MIXING PLANTS.

A. **General.** The drum-dryer hot mix plant shall meet Sections 152.01 and 152.02.

The drum-dryer mixing process shall provide positive weight control of the cold aggregate feed with a belt scale or other device to automatically regulate the feed gate and permit instant correction of variations in load. The cold-feed flow shall be automatically coupled with the bitumen flow to maintain the required proportions. The system shall be equipped with automatic burner controls and shall provide for temperature sensing of the bituminous mixture at discharge.

The Contractor shall have, for review by the Department, a copy of the manufacturer's manual for the plant. The pitch of the drum shall be no greater than 3/4 inch per foot or as recommended by the manufacturer.

When plant production is changed during normal operations, the temperature of the mix shall be maintained within 20°F. of the average temperature of the mix produced within the preceding 1/2 hour of the plant production change.

B. **Surge Bins.** The plant shall have adequate bin storage for the hot mix to ensure continuous production operations. Surge bins for hot storage shall have batchers, baffle plates, or other approved devices to minimize segregation during loading and unloading. Surge bins which permit an uninterrupted free fall of material from the loading conveyor shall not be used.

152.05 MILLING MACHINE.

The milling machine shall be a self-propelled machine specifically designed to mill and remove existing asphalt pavement to a specified depth, profile, cross slope, and

surface texture. The machine shall be of a size, shape, and dimensions which does not interfere with safe traffic passage adjacent to the work.

The machine shall have a control system to automatically control the elevation and transverse slope of the milling head. A 15-foot minimum length skid, rolling straight-edge or other approved device shall be used to establish the grade reference for control of the milling head. The system shall permit the grade reference device to operate on either side of the milling machine, and shall maintain the desired transverse slope regardless of changes in the elevation of the milling head.

Conveyors capable of side, rear, or front loading shall be provided with the necessary equipment to transfer the milled material from the roadway to a truck.

152.06 ASPHALT TRANSPORTER.

Tank trucks used to transport bituminous material shall be sealed at the refinery and shall be equipped with a bitumen sampling valve. This valve shall be conveniently located for sampling, preferably in the lower half of the rear bulkhead and at least one foot from the shell. The valve shall be inside the tank with the valve stem and outlet extending outside the tank.

SECTION 153 PORTLAND CEMENT CONCRETE EQUIPMENT

153.01 BATCHING AND WEIGHING EQUIPMENT.

- A. **General.** The batching plant, including its supports and foundations, shall be designed to safely withstand any operating stresses. The plant shall be leveled to maintain accuracy of the weighing mechanism. Bins with suspended weighing equipment shall be fully loaded for a minimum of two hours before testing the weighing equipment. The weighing mechanism shall be constructed or shielded to provide protection and accurate operation during windy or other adverse weather conditions.

The batching plant shall include individual bins or a bin with individual compartments, for each separate aggregate component, constructed to prevent intermixing of aggregate before weighing. The weigh hopper or hoppers shall be charged to assure the batched weights are within the tolerances specified in Section 802.04 B.1. The separate aggregate components for each batch may be weighed cumulatively in a single hopper or separately in individual hoppers. When weighed cumulatively, the aggregate shall be weighed in the specified sequence. A scalping screen or other device which is capable of removing deleterious, oversized material from the aggregate prior to charging the bins shall be placed on each bin at the batching plant.

Bulk cement and fly ash shall be weighed in a hopper and kept separate from the aggregates. The hoppers shall be attached to a separate scale for weighing compo-

ment materials. Bulk material shall be charged into the weigh hopper from a weatherproof bin equipped to permit accurate control of the quantity of material withdrawn for each batch, within the tolerance specified in Section 802.04 B.1.

The hoppers for weighing any ingredients shall be freely suspended on scales without other contacts that may affect proper functioning of the scales. The weigh hoppers shall complete discharge without loss of materials and without manual assistance. If complete discharge cannot be obtained, the hoppers shall be equipped with a vibrator. Hoppers shall hold the materials being weighed without spillage and the discharge gates shall not leak when closed.

Hoppers which are loaded by compressed air shall be vented to relieve air pressure build up. This build up could cause faulty operation of the weigh mechanism or result in false scale readings.

Weigh hopper scales shall be either the beam or springless dial type, of standard make and design equipped to permit quick, easy balancing at zero load. The scales shall be accurate within a tolerance of 0.5 percent throughout the range of use. For dial scales the predetermined batch weight of each ingredient being weighed shall be marked on the dial face by an adjustable pointer. Beam scales shall be equipped with an "over and under" indicator to show the beam in balance at zero load and provide positive visual evidence of overweights and underweights. The beam scale shall include a separate beam for each ingredient being weighed.

The Contractor shall have the scale tested and certified by the Department of Weights and Measures or a certified scale service within 6 months before use on the Project.

The scales shall be tested as often as the Engineer deems necessary for continued accuracy. The Contractor shall provide at least one standard 50-pound test weight for each 500 pounds of capacity of the maximum size scale; however, not less than 10 nor more than 20 such test weights shall be required. Any scale which cannot be maintained accurately within the specified tolerance shall be replaced or repaired. The Contractor shall make all arrangements and bear all expenses incurred in having the scales tested and certified.

- B. Automatic Batching Equipment.** Automatic batching shall be required for P.C.C. Pavement projects with 3,000 or more cubic yards of concrete. The automatic batching equipment shall conform to the general requirements of Section 153.01 A and to the additional requirements of this Section.

For each batch a single actuation of a starting device shall be the only manual operation permitted to proportion the designated quantity of each ingredient into the weigh hopper or hoppers.

The automatic batching equipment shall be interlocked so that: (1) The charging mechanism of any weigh hopper cannot be opened until the scale has returned to zero and the discharge mechanism of the weigh hopper has closed; (2) the discharge mechanism of the weigh hopper cannot be opened if the charging mechanism is open; (3) the discharge mechanism cannot be opened until all ingredients have been batched to their designated weights, within the specified tolerances; and (4) if separate aggregate components are weighed cumulatively in a single hopper, the aggregates are weighed in the specified sequence.

The designated batch weight of bulk cement and fly ash and of each separate aggregate component shall be preset at the direction of the Engineer before the batch cycle starts.

The automatic scales for weighing bulk cement and fly ash shall be equipped with an automatic recording device to graphically record or print the batched and empty weights. Graphic recording charts shall be graduated for time intervals not exceeding 15 minutes, and shall have minimum weight graduations not greater than 0.1 percent of the nominal capacity of the scale. If printed tapes are used, they shall record the consecutive batch number; and the minimum weight graduation printed on the tape shall not exceed 0.1 percent of the nominal capacity of the scale. The weight recording mechanism shall be accurate within one graduation of the chart or tape.

The automatic batching equipment shall be capable of conversion to manual operation. Manual operation will be limited to 12 hours for reasons of breakdown in the automatic equipment, except by written permission of the Engineer.

153.02 MIXERS.

- A. **Stationary Mixers.** Each mixer shall be a mechanically operated revolving drum or revolving blade type. The mixer shall have attached, in a prominent place, a manufacturer's certified rating plate showing the maximum mixer capacity, the recommended speed of rotation of the drum or blade (rpm), and the mixer's registration number. The mixer shall have a rated capacity of not less than 10 cubic feet. A mixer of smaller capacity may be approved for items of work other than Concrete Pavement (Section 550) and Concrete Structures (Section 602) provided the volume of concrete required for the pour is less than 10 cubic yards.

The total production capacity of the mixer or mixers shall be adequate to furnish concrete at a rate which permits uninterrupted placement and finishing operations.

The mixer shall be cleaned at intervals required to keep deposits of hardened concrete from accumulating in the mixer drum. The pick up and throw over blades shall be repaired or replaced when blade wear exceeds 10 percent of the original blade depth. The Contractor shall: (1) have available at the job site a copy of the manufacturer's design showing the original layout and dimensions of the blades, or (2) place permanent marks on each blade to show points of 10 percent wear from new conditions.

Multiple compartment mixers shall be designed for synchronized operation of the charging, mixing, transfer, and discharge cycles so that a single batch will not become intermingled in the mixer with material from another batch.

Each mixer with a capacity of 10 cubic feet or more shall be equipped with a water measuring system. When the mixer has a rated capacity less than 10 cubic feet, the mixing water may be measured and added by approved manual methods. The water measuring system may be mounted on a mixer or may be a separate unit located at the mixing site. The system shall deliver the designated quantity of water for each batch within the tolerance specified in Section 802.04 B.1.e. The system shall be constructed so the water flow to the mixing drum automatically stops

when the designated quantity of water has been delivered. The system shall be readily adjustable and shall have an accurately calibrated indicator showing the quantity of water measured for each batch. Outside taps and valves or other approved means shall be provided to permit convenient and accurate calibration of the water measuring system. The Contractor shall furnish all equipment and assistance necessary to calibrate the system before use and as necessary to maintain the specified tolerances.

A visual volumetric measuring unit must be used in all admixture dispensing systems where the admixture dosage rate does not exceed 32 fluid ounces/100 pounds of cement. The measuring unit shall be located where the plant operator can clearly read the index points on the measuring unit from the operator's station. A measuring unit will not be permitted in a plant where the batching office and batch plant are widely separated or where the batch cycle time is insufficient to allow the fill and discharge of a measuring unit. In such cases, a flow indicator must be installed in the admixture line to indicate to the plant operator the start and completion of each batch. Also, a suitable measuring unit must be installed in the line to allow checking the dispenser accuracy periodically. A separate dispenser is required for each admixture.

The revolving drum type stationary mixer shall have a manufacturer's guaranteed capacity capable of mixing and holding a volume of concrete equal to its rated capacity plus 10 percent without spillage. The revolving blade type stationary mixer shall mix and hold a volume of concrete equal to its rated capacity without spillage. The speed of rotation of the mixing drum or blades shall be as specified by the manufacturer.

When the stationary mixer has rated capacity of less than 10 cubic feet, the mixing cycle may be timed by any method approved by the Engineer. When the rated capacity of the mixer is 10 cubic feet or more, the mixer shall be equipped with controls for automatically timing the mixing cycle for each batch. The automatic timing controls shall be interlocked with the discharge mechanism so no part of the batch can be released until the designated mixing time has elapsed. The completion of each mixing cycle shall be indicated by an audible or visual signal. The timing mechanism shall be constructed or enclosed so it can be locked when directed by the Engineer. If the timing device or interlocks break down or fail to operate properly, operation of the mixer may be temporarily controlled by an approved manual timer until repairs can be made, provided a mixing time for each batch of not less than 90 seconds can be maintained. If repairs are not completed within 72 hours, further use of the mixer shall be discontinued. Each stationary mixer used to mix concrete for pavement shall be equipped with an approved mechanical batch counter.

- B. Truck Mixers.** The maximum cubic yard capacities for mixing and agitating shall be as guaranteed by the manufacturer on the rating plate attached to the truck mixer. The mixing speed for the revolving drum type mixer shall be not less than four revolutions per minute of the drum, nor greater than a speed resulting in a peripheral velocity of 225 feet per minute at the largest diameter of the drum. The mixing speed for the revolving blade type mixer shall be not less than four nor more than 16 revolutions per minute of the mixing blade. The agitating speed for either the revolving drum or revolving blade type mixer shall be not less than two nor more than six revolutions per minute. The truck mixer shall be equipped with a

revolution counter which registers the number of revolutions of the mixing drum or blades when operated at mixing speed.

The mixer shall be cleaned at intervals, required to keep deposits of hardened concrete from accumulating in the mixer drum. The pick up and throw over blades shall be repaired or replaced when blade wear exceeds 10 percent of the original blade depth. The Contractor shall: (1) have available at the job site a copy of the manufacturer's design showing the original layout and dimensions of the blades, or (2) place permanent marks on each blade to show points of 10 percent wear from new conditions.

When the truck mixer carries flush water for cleaning the mixer, it shall be carried in a compartment separate from the mixing water, and each compartment shall be equipped with a calibrated sight gauge.

- C. **Mobile Mixers.** The mixer shall be self-propelled and carry sufficient unmixed materials for the concrete.

The maximum cubic yard capacity shall be as certified by the manufacturer on the rating plate attached to the truck mixer.

The mixer shall be capable of positive measurement of cement and flow of water being introduced into the mix. A visible cement recording meter shall be provided and equipped with a ticket printout showing the quantity used. Water flow shall be indicated by flow meter and be readily adjustable to provide for minor variations in aggregate moisture.

The mixer will be calibrated by the Department to ensure that it is capable of automatically proportioning and blending all components on a continuous or intermittent basis, as required by the finishing operation. The Contractor shall furnish a platform scale of 500-pound capacity, 300 pounds of test weights, a container that can be placed on the scale, and a deflector to divert the material from the mixer into the container. Each individual component (aggregate, sand, water, cement, and admixture), shall be calibrated individually and as a component.

The total production capacity of the mixer or mixers shall be adequate to furnish concrete at a rate which permits uninterrupted placement and finishing operations.

The mixer shall be cleaned at suitable intervals, and accumulations of hardened concrete shall be removed.

153.03 CONCRETE TRANSPORTING EQUIPMENT.

- A. **General.** Any equipment used to transport freshly mixed concrete shall deliver the concrete in a thoroughly mixed and uniform mass, meeting all requirements for slump, air content, and uniformity when discharged at the site. The equipment shall have gates or other approved means for controlling the discharge rate as well as vibrators to aid in the discharge.

Equipment used for concrete placement, such as truck boxes, chutes, pipes, buckets, shovels, or wheelbarrows shall not contain aluminum.

- B. **Agitators.** Agitating equipment shall be of the revolving-drum or open-top revolving-blade types, or may be a truck mixer operated at agitating speed. The agitating speed of the revolving drum or blades shall be not less than two or more than 6 revolutions per minute. The body or drum shall be a smooth, watertight, metal container. The maximum cubic yard hauling capacity shall be shown on a rating plate attached to each unit.

153.04 SIDE FORMS.

Straight side forms shall be made of a metal of not less than 7/32 inches thick and not less than 10 feet long. Flexible or curved forms of proper radius shall be used for curves of 100-foot radius or less. Form design shall be acceptable to the Engineer; and the forms shall have adequate devices for secure setting so that when in place they withstand, without spring or settlement, the weight impact and vibration of the consolidating and finishing equipment. Flange braces shall extend outward on the base not less than 2/3 the height of the form. Forms with battered top surfaces, and forms that are bent, twisted, or broken shall be removed from the work. Repaired forms shall not be used until inspected and approved. Built-up forms shall not be used. The top face of the form shall not vary from a true plane more than 1/8 inch in 10 feet and the upstanding leg shall not vary from a true plane more than 1/4 inch in 10 feet. The forms shall contain provisions for locking the ends of abutting form sections together tightly and for secure setting. Forms shall be cleaned and oiled before use. Forms of other approved section and material may be used when it is not required that the forms support mechanical fine grading or paving equipment.

153.05 SLIP FORM PAVING EQUIPMENT.

All equipment shall be self-propelled; and designed for the specific purpose of placing, consolidating, and finishing the concrete pavement true to grade and cross section in one complete pass without the use of fixed side forms. No external tractive force shall be applied to the machine.

When placing and finishing portland cement concrete pavement with slip form paving equipment, the paving equipment shall be equipped with vibrators and a vibrator monitoring system meeting the following requirements:

- A. **Vibrators.** The slip form paving equipment shall be capable of consolidating the full width and depth of concrete in a single pass using an approved internal or surface vibrator. Internal vibrators shall be operable over the entire frequency range of 3,500 to 8,000 vibrations per minute. Surface vibrators shall be operable over the entire frequency range of 3,000 to 6,000 vibrations per minute. However, both types of vibrators shall be operated as specified in Section 550 of the Standard Specifications.

Horizontal spacing of vibrators shall not exceed the manufacturer's recommendations, but in no case exceed 16 inches from center to center.

The longitudinal axis of the vibrator body shall be mounted approximately parallel to the direction of paving with the exception that the trailing end of each vibrator shall be tilted downward to an approximate slope of 15 degrees below horizontal.

Vibrators shall meet or exceed the following specifications at manufacturer's design frequency of 10,000 vpm:

1. Amplitude (peak to peak) 0.070 inches (1.75 mm)
2. Centrifugal force 1,200 pounds (5500 N)

B. Vibrator Monitoring System. An electronic monitoring device displaying the operating frequency of each individual internal vibrator shall be provided for slip-form paving equipment.

The monitoring device shall have a readout display near the operator's controls and be visible to the paver operator and the Engineer. It shall operate continuously while paving, and shall display all vibrator frequencies with manual or automatic sequencing among all individual vibrators. The monitoring system shall be capable of producing the record required in Section 550.04 G.3.

153.06 ROADBED PLANERS.

The roadbed planer shall be constructed of steel and shall be mounted on tracks. The planner shall be heavy enough to trim the roadbed to the specified tolerance with a frame capable of maintaining the required crown under all operating conditions.

The planer shall be equipped with rotary cutting mechanisms capable of trimming the subgrade and base to the required lines and grades within the tolerances of Section 302.04 F.3 Surface tolerance Type C. The equipment shall be capable of trimming in sufficient width in one pass to allow the placement of the 28-foot concrete slab.

The planer shall be equipped with automatic grade control that maintains the proper elevation at both sides of the paver by: (1) controlling the elevation of one side and the crown, or (2) controlling the elevation of each side independently. The grade reference shall be an erected string line or other approved method.

The string line control shall consist of a tightly stretched wire or string, offset from and parallel to the pavement edge on one or both sides, and set parallel to the established grade for the pavement surface. The line shall be supported at intervals required to maintain the established grade and alignment.

153.07 CONCRETE SPREADERS.

The spreader shall be self-propelled and capable of spreading the concrete mix to the desired cross sections. The spreader shall be easily adjustable to spread different thicknesses of concrete.

153.08 VIBRATORS.

Vibrators for full width vibration of concrete paving slabs may be either the surface-pan type or the internal-spud type with either immersed tube or multiple spuds. The vibrators may be attached to the spreader or the finishing machine, or may be mounted on a separate carriage. They shall not come in contact with the joint, load transfer devices, subgrade, or side forms. The frequency of the vibrators shall meet the manufacturer's recommendation.

The Contractor shall have available, for the Engineer's use, the proper equipment for determining the frequency of the impulses of the vibrators.

153.09 CONCRETE FINISHING MACHINES.

All concrete finishing machines shall meet the following requirements:

- A. **Transverse Finishing Machines for P.C.C. Pavement.** Each transverse finishing machine shall be self-propelled and be fully and accurately adjustable to produce the specified crowned or flat surface as required.

The finishing machine shall be sufficiently powered, geared, and operated to strike off, screed, and consolidate the concrete consistently, regularly, and smoothly to specified tolerances.

- B. **Bridge Deck Finishing Machines.** A self-propelled finishing machine shall be used to strike off and finish the concrete after it has been placed and consolidated. The finishing machine shall be mounted on wheels which ride on a track and have one or more power-driven oscillating or rotating screeds.

The finishing machine shall be adjustable to the specified crown and elevation to maintain the required concrete cover over the reinforcing steel. The finishing machine shall be wide enough to finish the deck in one pass.

- C. **Finishing Machines for Bridge Deck Overlays.** The finishing machine shall have a mechanical strike off to provide a uniform thickness of concrete in front of an oscillating screed or screeds. The screed shall be long enough to uniformly strike off and consolidate the width of the lane to be paved. The finishing machine shall be capable of forward and reverse motion under positive control.

At least one oscillating screed shall be capable of consolidating the concrete to the specified density. Each screed shall have an effective weight of at least 75 pounds for each square foot of bottom face area. Each screed shall be provided with positive control of vertical position, the angle of tilt, and the shape of the crown.

Rails, with fully-adjustable supports (not shimmed), shall be required for the finishing machine to travel on, and shall be placed outside the area to be paved.

Rail anchorage shall provide horizontal and vertical stability and the anchors shall not be attached to concrete by use of powder actuated fasteners unless that concrete is to be subsequently overlaid.

153.10 HAND FINISHING EQUIPMENT.

- A. **Screeds.** The manually operated screed shall be of metal construction or metal shod shaped to the designated crown of the pavement, with sufficient rigidity to maintain that crown under working conditions. The screed shall be at least 2 feet longer than the maximum width of slab to be screeded. Unless the concrete is satisfactorily consolidated by vibration before screeding, the screed shall be equipped with an approved vibratory unit.

Manually operated screeds will be allowed only on driveways, concrete tapers, sidewalks, and concrete pavement repair of less than 20 feet in length. Roller screeds may be used if there is no visible deflection or bounce of the tube while screeding. The tube shall be straightedged prior to using.

- B. **Straightedges.** The straightedge shall be 10 feet long with an accurate, rigid contact edge designed to test the surface trueness of the pavement, to cut or fill minor surface irregularities, and to remove excess water or laitance from the surface of the pavement. The contact edge shall be periodically tested and adjusted as necessary to assure that the edge has no deviation from a true plane. The straightedge shall be rigidly mounted on a handle of sufficient length to permit its operation over not less than 1/2 the width of the slab from a position outside the forms.

153.11 SPRAYERS FOR LIQUID CURING COMPOUND.

When the pavement is cured by a liquid membrane-forming compound, the compound shall be applied by a self-powered machine with a mechanical-pressure distribution system designed to provide uniform and specified coverage of the pavement. The spray nozzles shall be enclosed by a hood to minimize loss of curing compound during windy conditions. An approved hand-operated sprayer may be used when liquid curing compound is applied to the sides of the pavement slab or to areas of pavement where work dimensions or other features make using a self-powered sprayer impractical.

153.12 CONCRETE SAWS.

Saws shall be adequately powered and furnished with suitable blades to effectively cut pavement joints to required dimensions. Each blade of multiple-blade saws shall be maintained in accurate alignment to the other blades. A device shall be provided to guide the saw along the required joint alignment. Manual guidance of the saw will be permitted if specified results are obtained. A sufficient number of sawing units shall be available to maintain required progress and provide prompt replacement in case of breakdown. Adequate artificial lighting shall be provided for night sawing.

153.13 JOINT AND CRACK CLEANING AND SEALING EQUIPMENT.

- A. **General.** Joints shall be sawed with a diamond blade saw meeting Section 153.12.

Air compressors shall be equipped with traps for removing all free water and oil from the compressed air and furnish air in excess of 90 psi.

- B. **Hot Poured Joint Sealant.** The heating kettle shall be of the indirect heating, double-boiler type, using oil or other suitable material as the heat transfer medium. The kettle shall have a thermostatically controlled heat source, accurate temperature indicating devices, and an effective mechanical agitator.

The pressure-type applicator shall completely fill the joint from the bottom up to the required height, without overflow or spillage of sealing compound onto the pavement surface.

- C. **Silicone Sealant.** The mechanical device for applying silicone sealant shall be suitable for the intended use, and shall be equipped with a nozzle or spout shaped to fit into the joint for introducing sealer from the bottom up.

153.14 PREFORMED ELASTOMERIC COMPRESSION JOINT SEAL EQUIPMENT.

Prefomed elastomeric compression joint seal shall be installed with a mechanical device as recommended by the seal manufacturer.

153.15 GRINDING MACHINE.

Grinding shall be performed with a device specifically designed for concrete pavement grinding. The machine shall be a power-operated mechanical grinder equipped with diamond blades and capable of uniformly grinding or removing the old surface to depths required without damaging the underlying concrete.

153.16 HYDRODEMOLITION EQUIPMENT.

Hydrodemolition equipment shall consist of a water filtering and pumping unit operating in conjunction with a remotely controlled robotic water jet unit.

The equipment shall remove sound and unsound concrete to the specified depth and shall remove rust and concrete particles from exposed reinforcing bars with high velocity water jets acting under continuous automatic control.

The equipment shall be calibrated by adjusting water pressure, robot speed, and jet oscillation speed so the required level of removal can be achieved.

All water used in hydrodemolition equipment shall be potable. Stream or lake water shall not be used.

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SECTION 201 CLEARING AND GRUBBING

201.01 DESCRIPTION.

This work consists of clearing, grubbing, removing, and disposing of all vegetation and debris within designated limits of the Right of Way and Easement area. Vegetation and objects designated to remain shall be preserved from damage or defacement.

201.02 CONSTRUCTION REQUIREMENTS.

- A. **General.** The Engineer will establish Right of Way and construction lines and designate all trees, shrubs, plants, and other items to remain. If trees or shrubs selected for retention are cut or scarred during construction activities, any loose bark shall be removed and broken branches shall be pruned.
- B. **Clearing and Grubbing.** Clearing and Grubbing includes the removal and disposal of trees, shrubs, stumps, roots, brush, and other surface objects from the excavation and embankment areas.

Trees located within the boundaries of the new grade shall be removed to a depth of 18 inches below the finished ground line or 3 feet below the final dirt grade, whichever is lower. Trees located outside the boundaries of the new grade shall be removed to a depth of 18 inches below the finished ground line. Existing stumps shall be removed to the same depth specified for tree removal.

Except in areas to be excavated, all cavities resulting from the removal of obstructions shall be backfilled and compacted with suitable material. Compaction shall meet the requirements in Section 203.02.1.

Perishable material may be burned if burning is permitted by, and done under applicable laws and ordinances. Burning shall be done under the care of competent watchpersons at such times and in a manner that does not jeopardize surrounding vegetation and adjacent property.

Clearing and Grubbing, if wasted, must be disposed according to Section 107.10—“INERT WASTE DISPOSAL.”

All salable timber in the clearing area shall become the Contractor’s property.

Low hanging, unsound, and unsightly branches on remaining trees or shrubs shall be removed. Tree branches extending over the roadbed shall be trimmed to give a clear height of 20 feet, or according to local ordinances. All trimming shall be done using good tree surgery practices.

- C. **Topsoil Removal.** Removing, salvaging, stockpiling, and spreading of topsoil shall be as specified in Section 203.02 B.

201.03 METHOD OF MEASUREMENT.

Measurement will be by one or more of the following alternate methods:

A. **Area Basis.** Measurement will be by the number of acres and fractions of acres acceptably cleared and grubbed within the limits shown on the Plans or staked by the Engineer. Areas not shown on the Plans, or not staked for Clearing and Grubbing, will not be measured for payment.

B. **Lump Sum Basis.** When the bid schedule contains a Clearing and Grubbing Lump Sum item, no measurement of area will be made.

When the removal and disposal of trees, shrubs, stumps, roots, brush, etc., in excavation and embankment areas is not specified on an individual unit basis, removal and disposal will be included in the Lump Sum price bid for Clearing and Grubbing.

C. **Linear Basis.** When the linear unit quantity is shown on the bid schedule, the length will be measured along the construction centerline in Stations or Miles.

D. **Individual Unit Basis.**

1. The diameter of trees shall be measured at a height of 24 inches above the ground. Payment for Stump Removal shall only be made for removing existing stumps. Stumps shall be measured by the average diameter of the stump at ground level. Trees or stumps 8 inches or less in diameter are classified as brush.
2. When the bid schedule indicates measurement of trees and stumps by individual unit basis, they will be designated and measured according to the following schedule of sizes:

Diameter at Height of 24 inches	Pay Item Designation
Over 8 inches to 12 inches	10-inch size each
Over 12 inches to 24 inches	18-inch size each
Over 24 inches	30-inch size each

201.04 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Clearing and Grubbing	Acre, Stations, Miles, Lump Sum
Tree Removal	Each
Stump Removal	Each

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

Exclusions. When the Bid Schedule does not contain an estimated quantity or a Lump Sum item for Clearing and Grubbing, the work will not be paid for directly but will be included in other Contract items.

**SECTION 202
REMOVAL OF STRUCTURES, OBSTRUCTIONS,
SURFACING, AND MISCELLANEOUS ITEMS**

202.01 DESCRIPTION.

This work consists of razing, removing, salvaging, and disposing of all buildings, foundations, fences, structures, abandoned pipelines, culverts, pavements, manholes, inlets, sidewalks, driveways, curb and gutter, and other obstructions or items on the right of way or easement areas which are not designated or permitted to remain. It shall include salvaging designated materials, and backfilling resulting cavities. Material shall not be disposed of in wetlands areas. Proper disposal of inert waste is covered in Section 107.10.

202.02 CONSTRUCTION REQUIREMENTS.

- A. **General.** All designated salvageable material shall be removed without damage and transported in sections or pieces to specified storage locations. All removed material not designated to be salvaged or disposed of at specified locations, shall become the property of the Contractor. If the Contractor chooses to waste the removed materials, it shall be disposed of according to Section 107.10.

Except in areas to be excavated, basements or cavities left by structure removal shall be backfilled to the level of the surrounding ground. Before backfilling, any remaining concrete slabs shall be broken so that water does not get trapped in the cavity. Cavities located within the area between the toes of the inslopes shall be backfilled and compacted under the same Specifications as the embankment. Cavities located outside these areas shall be compacted to the same level as the surrounding undisturbed ground. There will be no separate payment for excavating or for backfilling and compacting the remaining cavity resulting from the removal of structures and obstructions.

- B. **Removal of Bridges and Box Culverts.** Bridges and box culverts shall not be removed until satisfactory arrangements have been made to accommodate traffic.

Existing substructures shall be removed to the natural stream bottom, and those parts outside of the stream shall be removed one foot below natural ground surface. Portions of existing structures within the limits of a new structure shall be removed to accommodate the construction of the proposed structure.

Bridges, or portions of bridges, designated as salvaged material, shall be dismantled without damage, match marked, transported and stored at specified locations.

Blasting or other operations necessary to remove an existing structure or obstruction, which may damage new construction, shall be completed before starting the new work.

All concrete removed shall be disposed of under Section 202.02 A.

- C. **Removal of Pipe Culverts, Storm Sewers, and Storm Drains.** Pipe culverts, storm sewers, and storm drains designated for salvage shall be removed and stored without breakage or damage. Sections of pipe lost from storage or damaged by negligence shall be replaced at the Contractor's expense. Pipe designated for removal only will not be paid for unless a bid item is shown in the Plans and shall be disposed of under Section 202.02 A. Pipe designated to be plugged shall be left in place and the ends plugged with compacted earth or concrete. Pipe shall not be removed until satisfactory arrangements have been made to accommodate traffic. Disposal of excess excavation shall be off the right of way at a location approved by the Engineer.
- D. **Plugging Existing Pipe Culverts.** The pressure grout method shall be used to plug these pipes. The excavation to locate and pressure grout the pipes shall be on the high water side of the embankment. The pit shall be a minimum offset of 15 feet off the centerline of the roadway. Trench boxes and/or shoring will be required.

When pipes have been located, a hole shall be made in the top of the pipe. All water shall be pumped from the pipe to allow for placement of the grout in dry conditions. If this is not possible due to seepage, placement may be required under wet conditions. In either case, the pipe must be completely filled with grout and shall be required to attain an unconfined compressive strength of at least 150 psi within 28 days. The testing of the grout shall be in accordance with the Department's Standard Methods for determining compressive strength. Grout samples shall be taken every 14 CY for compressive strength. Grout injection pressures shall not exceed 50 psi to avoid embankment failure at the pipe ends.

Payment for grout is dependent on compressive strength of the samples. If the Contractor does not achieve strength of at least 150 psi within 28 days, a 25 percent pay reduction shall be assessed for every 5 percent below the specified 150 psi strength. If compressive strength is less than 80 percent of the standard, no payment shall be made for the 14 CY of grout represented by that sample.

Grouting equipment includes mixing and batching facilities, a pump specifically designed for pressure injection of grout, and pipe hose and fixtures to convey the grout into the pipe cavity. Calibration of all equipment shall be required before beginning work. The grout pump shall have a liquid-filled diaphragm in-line gauge so that pressures can be continuously monitored. The general method for grout injection is tremmie grouting. In this method, the grout pipe (tremmie) is placed at the far end (lowest) of the pipe cavity and the cavity is filled progressively from one end to the other. Grout pumping continues either until refusal (when no more grout can be pumped) or until grouting pressures reach the predetermined maximum.

- E. **Removal of Pavement, Sidewalks, Curbs, etc.** All concrete pavement, sidewalks, curbs, gutters, inlets, manholes, driveways, buildings, foundations, slabs, etc., as well as ballast, gravel, bituminous material, or other surfacing or pavement materials not designated for salvage shall be disposed of under Section 202.02 A.

Where portions of an existing structure, pavement, curb, gutter, sidewalk, or similar item are to be left in the surface of the finished work, removal shall be to an existing joint, or sawed to a specified vertical face.

The removal and salvage of bituminous pavement scheduled for use as bituminous surfacing shall be in accordance with Section 405. All material salvaged for reuse as base material shall be removed so the material is not contaminated with dirt or other foreign material. The removal and salvage of P.C.C. pavement for use as recycled P.C.C. pavement shall be in accordance with Section 560.

Removal of manholes or inlets shall consist of removing the casting, rings, barrel and base; plugging or capping the existing lines; and backfilling to grade. All labor, equipment, materials, and disposition of items involved in the removal shall be included in the bid price for "Removal of Manholes" or "Removal of Inlets."

- F. **Removal of Monuments and Markers.** Any existing monuments or markers designated for removal shall not be paid as separate bid items. All costs for labor, material, and equipment needed to remove and dispose of the monuments or markers according to Section 107.10, shall be included in the price bid for other items.

202.03 METHOD OF MEASUREMENT.

When the Proposal Form stipulates payment will be made for obstruction removal on a Lump Sum basis, the pay item will include all structures and obstructions encountered within the Right of Way and easement areas according to the provisions in this Section. When payment will be made for removal of specific items on a unit basis, measurement will be made by the Lump Sum, Each, Linear Foot, Square Yard, Cubic Yard, or Ton, as stipulated in the Proposal. The sawing of concrete and bituminous surfacing will be measured by the Linear Foot.

Excavation and disposal of excess excavation for Removal of Pipe Culverts will not be measured for payment, but shall be included with other items bid.

202.04 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price for the following:

Pay Items	Pay Unit
Removal of Structures and Obstructions	Lump Sum
Removal of Structure	Each, Lump Sum
Removal of Box Culvert	Each, Lump Sum
Removal of Concrete	Lump Sum, Square Yard, Cubic Yard, Ton
Removal of _____ Surfacing	Square Yard, Cubic Yard, Ton
Removal & Salvage of _____ Surfacing	Square Yard, Cubic Yard, Ton
Removal & Salvage Culverts, All Types & Sizes	Linear Foot
Removal of Curb & Gutter	Linear Foot
Saw Concrete	Linear Foot
Saw Bituminous Surfacing	Linear Foot
Removal of Manholes	Each
Removal of Inlets	Each
Removal of _____	(Any of Above)

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

Exclusions. When the Bid Schedule does not contain an estimated quantity or a Lump Sum item for “Removal of Structures and Obstructions,” and the structure or obstruction is shown on the Plans, the work will not be paid for directly but will be included in other Contract Items. If the structure or obstruction is not shown on the Plans and removal is directed by the Engineer, payment will be made according to Section 104.03.

SECTION 203 EXCAVATION AND EMBANKMENT

203.01 DESCRIPTION.

This work includes the excavation, haul, placement and compaction of embankment, and disposal, if necessary, of material encountered within the limits of work necessary for construction of the roadway. Excavation in this Section will be classified as “Common Excavation,” “Rock Excavation,” “Muck Excavation,” “Shale Excavation,” or “Borrow Excavation,” as described below.

- A. **Common Excavation.** Common Excavation consists of all excavation not otherwise classified. If encountered, coal will be measured and paid for as Common Excavation and shall be deposited outside the construction limits at designated locations, or at locations acceptable to the Engineer.

Types of excavation according to compaction control methods shall be as follows:

Type	Section
1. Common Excavation with Compaction Control, Type A	203.02 G
2. Common Excavation with Compaction Control, Type B	203.02 H
3. Common Excavation with Type C Embankment	203.02 I

- B. **Rock Excavation.** Rock Excavation consists of excavating hard solid rock in ledges and bedded deposits which is so hard or firmly cemented that it must be blasted before it can be excavated and removed; or that heavy duty dozer-mounted rippers or dozer blades must be used to break the material into chunks. Material that breaks or shatters into pieces of less than one cubic foot in size during breaking operations (excluding blasting) will be classified as shale.

Rock excavation includes all boulders and other detached rock having a volume of 1/2 cubic yard or more.

If no bid item is provided for Rock Excavation, and rock is encountered which must be blasted or ripped as described above, the material will be paid for as shown in the Price Schedule PS-1.

- C. **Shale Excavation.** Shale Excavation includes the excavating of shale material consisting of laminated, fissile, sedimentary material composed principally of fine grained particles. The Contractor must demonstrate to the Engineer that the

material is shale and cannot be removed by conventional scrapers and dozers and must be ripped by use of heavy-duty rippers of a type normally rear-mounted on dozers or similar equipment. If the material can be ripped using a motor grader equipped with ripper/scarifying teeth, it will be paid for as Common Excavation.

When shale is a bid item, Section 104.04 will not apply. If no bid item is provided, and shale is encountered which has to be ripped before removal, as described above, the material will be paid for as shown in the Price Schedule PS-1.

- D. **Muck Excavation.** Muck Excavation consists of the removal and disposal of deposits of saturated or unsaturated mixtures of soils and organic matter unsuitable for use as embankment material; and cannot be removed by use of conventional scrapers and dozers, but must be removed by equipment such as draglines, shovels, or excavators which operate outside the area being excavated.

If no bid item is provided for Muck Excavation, and muck is encountered which requires removal as described above, the material will be paid for as shown in the Price Schedule PS-1.

- E. **Borrow Excavation.** Borrow Excavation consists of excavation, haul, placement, and compaction of embankment material obtained from locations outside the Right of Way. The borrow areas may be either Department-optioned or Contractor-furnished, as shown in the Contract or as approved by the Engineer.

203.02 CONSTRUCTION REQUIREMENTS.

- A. **General.** The excavation and embankments shall be finished to smooth and uniform surfaces. No excess material shall be disposed of without permission of the Engineer. Excavation operations shall be conducted without disturbing material outside the slope limits. Before beginning excavation, grading, and embankment operations, all necessary clearing and grubbing in the area shall have been performed according to Section 201.

Borrow material should not be placed until all roadway excavation has been placed in the embankment. If more borrow is placed than is required and causes a waste of excavation, the quantity of waste will be deducted from the volume measured in the borrow area. If more embankment is placed than is required, the excess embankment quantity will be deducted from the volume of borrow or excavation measured for payment.

1. **Rock Subcut.** Material classified as rock shall be excavated to a minimum depth of 6 inches and a maximum depth of 12 inches below subgrade within the limits of the roadbed. The excavation shall be backfilled with material designated on the Plans or approved by the Engineer. Rock removed in excess of 12 inches below subgrade will not be measured or paid for.

Rock excavation backfill in excess of 12 inches below the subgrade will be at the Contractor's expense.

2. **Roadway Obliteration.** Limits of obliteration of old roadways will be shown on the Plans. Obliteration includes removal of roadway surface material, structures, and appurtenances, filling in of all ditches, rough grading, placing of topsoil, and seeding. The original ground contour shall be restored to present an appearance of natural rounded slopes.

3. **Unsuitable Material.** Unsuitable material encountered in the subgrade shall be removed to the depth directed and disposed of under Section 203.02 D. Construction operations shall be conducted so necessary measurements can be taken before replacing unsuitable material with satisfactory backfill.
 4. **Second Handling.** When excavation which requires more than one handling before final placement due to circumstances beyond the Contractor's control, the second handling will be paid as agreed upon before the work by:
 - a. A negotiated price.
 - b. Extra Work according to Section 104.03.
 5. **Coal.** When coal is encountered, it shall be removed to a depth of 6 feet below the subgrade profile between the graded shoulders. From the graded shoulders to the top of the backslopes, it shall be removed to a depth of 1 foot below the final surface elevation. All coal removed shall be paid for as Common Excavation.
- B. Salvaging, Stockpiling, and Spreading Topsoil.** Topsoil shall be removed from all excavation and embankment areas, and stockpiled on the Right of Way at designated or acceptable locations outside the grading limits. Salvaged topsoil that is stockpiled within the clear zone must be stockpiled in a manner that is safely traversable. The stockpile must have slopes which are 4:1 or flatter if they are located within the clear zone. Additional areas outside the Right of Way required to stockpile topsoil shall be obtained by and at the Contractor's expense. Topsoil shall be removed to its full depth, but not to exceed 6 inches. The equipment and methods shall be adjusted to avoid the removal of subsoil or other unsuitable material. Hauling of topsoil shall not exceed the Plan haul limits. All stockpiled topsoil shall be spread evenly over the entire area of the new roadway except the roadbed.
- C. Subcut.** In areas designated to be subcut, the roadbed shall be excavated and removed below the proposed grade line within the horizontal and vertical limits shown on the Plans.
- All subcut excavations shall be performed with a backhoe using a smooth cutting edge to minimize disturbance of underlying soils. A 20:1 transition shall be constructed prior to entering and exiting subcut excavations. Construction equipment will not be allowed to travel on the soft subgrade.
- R1 reinforcement fabric, meeting the requirements of Section 709, shall be placed at the bottom of the subcut excavation.
- Subcut sections shall be backfilled and compacted with Class 3, Class 5, or salvaged aggregate. Compaction of aggregate for subgrade repair shall comply with Sections 302.04 D.
- D. Disposal of Surplus and Unsuitable Material.** Excavated materials designated as waste or unsuitable shall be disposed of at sites selected by the Contractor and acceptable to the Engineer. All rocks and boulders shall be buried under at least one foot of earth. All suitable surplus material shall be used to uniformly widen embankments and flatten slopes within the Right of Way. The Contractor

shall obtain and file with the Department, a copy of the written permission from the Landowner for disposal sites outside of the Right of Way. Waste or unsuitable material shall not be placed in wetlands. Payment will be made at negotiated prices according to Section 104.03.

E. Borrow.

1. **General.** Borrow material shall not be excavated beyond the dimensions and elevations established, or before staking and cross sectioning the site.

Topsoil, as shown in the Contract Documents, shall be removed and stockpiled before excavation of borrow material. The Contractor shall provide at least two working days notice to the Engineer to complete the necessary preliminary cross sectioning before removal of topsoil. An additional one working day notice shall be given before excavating borrow so topsoil measurements can be completed.

After excavation is complete, the borrow area shall be reshaped to insure accurate final cross sectioning of the borrow area and provide adequate drainage. Excavated slopes shall not be steeper than 8:1 except where blending into existing steeper slopes. Cartways shall be obliterated, reshaped, and all disturbed areas reseeded to meet the condition of the adjacent ground surfaces. The costs of obliterating, scarifying, reshaping, and reseeding of the cartways shall be included in the price bid for "Borrow Excavation."

Work shall be scheduled in all borrow areas to allow any utility company to relocate, adjust, or remove their facilities.

Borrow material shall not be removed within 5 feet of any buried facility, within 10 feet of any utility pole, or within 25 feet of any utility structure until the utility has been relocated, removed, or adjusted. The slopes around utilities shall not be steeper than 3:1.

After relocation, removal, or adjustment of the utility, all remaining material shall be removed to match the final adjacent elevations. The Contractor's operations shall be coordinated with the utility companies.

The Department will be responsible for utilities relocations and costs of relocations in Department-optioned borrow areas. The Contractor shall be responsible for any utility adjustment work in Contractor-furnished borrow areas.

Fencing removed to facilitate borrow operations shall be replaced to its original condition to the satisfaction of the landowner. The Contractor shall be responsible for confinement of livestock when fencing is removed or altered.

2. **Department-Optioned Borrow.** The Department may acquire an option and may assign the right to take materials from the sources described in the proposal. The Contractor shall notify the landowner in writing that the Contractor is exercising the Department's option to purchase materials under the terms and conditions provided in the option and any other terms and conditions which might be negotiated and agreed to between the Contractor and the landowner. A copy of the written notification to exercise the Department's

option, and any other agreement negotiated between the Contractor and the landowner regarding use of Department optioned pits, must be provided to the Engineer approximately 10 days before moving into a Department-optioned borrow area. The written notification to the landowner shall inform the property owner or agent of the removal plan and use of the cartway.

All Department-optioned borrow area data listed in the Proposal is preliminary borrow area information. Contractors are responsible for checking all listed borrow area information before bidding.

Information issued for Department-optioned borrow areas is for use by all Bidders on an equal competitive basis.

The Contractor shall verify from County records and furnish to the Engineer in writing the name(s) of the legal owner(s) of the borrow area during the time the borrow material was removed. The names of any other parties having a legal interest in the property shall be included in the written statement.

If the borrow area is not used after notifying the Department and landowner of the expected borrow area entry, the Contractor is liable for crop damage. If the borrow area is used, the Department is liable for crop damage. Crop damage will be paid according to the predetermined amount stated in the Proposal Form.

The removal, stockpiling, and spreading of topsoil shall be as specified in Section 203.02 B. Seeding shall be according to Section 708.02.

After the borrow area has been restored to a satisfactory condition, the Contractor shall obtain a release from the landowner or the landowner's authorized agent. The Contractor shall make the royalty payment to the landowner, including other parties with legal interest in the property, and shall obtain a receipt of payment. Cost of royalties shall be included in the price bid for borrow. A copy of the release and receipt of payment shall be furnished to the Department.

After the Contractor has removed the minimum quantity of borrow estimated in the borrow option, the Contractor shall pay the landowner and any other parties with legal interest in the property 80 percent of the minimum payment within 30 days after the Department has made payment to the Contractor. The balance of the royalty payment shall be paid within 30 days after the Department supplies the Contractor with final quantities. Should the work be performed in more than one calendar year, payment for material removed from the optioned area during a calendar year shall become due on December 31 of that year. If a different payment arrangement is negotiated between the Contractor and the landowner, a copy of the agreement shall be filed with the Department.

If a material shortage or other problems occur in the Department-optioned area, and the Contractor is directed to furnish borrow from an alternate site, payment for topsoil and seeding will be made on the basis shown for the Department-optioned area. The Contractor will be reimbursed for any costs or hauls in excess of what would be incurred in the Department-optioned area. Measurement for added haul will be according to Section 203.03 E.

3. **Contractor-Furnished Borrow.** Unless the Department-optional borrow areas listed in the Proposal Form are mandatory, the Contractor may obtain the borrow from another source. If no Department-optional borrow is listed in the Proposal Form, the Contractor shall obtain a suitable borrow source. The Engineer will determine if the material from another source is suitable for the specified use.

The Contractor shall make arrangements for obtaining suitable borrow and shall bear all costs of obtaining, opening, and restoring the site.

In either circumstance, the Contractor's costs shall include but shall not be restricted to, royalty payments, removal and replacement of topsoil, reshaping and scarifying, obliterating cartways, crop damage, seeding, and any overhaul. After the borrow area has been restored to satisfactory condition, the Contractor shall obtain a release and receipt of payment from the landowner and furnish copies to the Department.

- F. **Embankment Construction.** Embankment construction includes preparation of areas upon which embankments are to be placed; construction of dikes inside or outside the Right of Way; placement and compaction of material in areas where unsuitable material has been removed; and placement and compaction of embankment material in holes, pits, and other depressions within the roadway area. Only approved materials shall be used in the construction of embankments and backfills.

Rocks, broken concrete, or other solid materials shall not be placed in embankment areas where piling is to be placed or driven. Rocks larger than 4 inches in its longest dimension shall not be placed in the top one foot of the finished grade.

Benching shall be required whenever embankment is placed against slopes 4:1 and steeper. The back of the bench shall be nearly vertical with the horizontal cuts being made as close together as slope permits, but with no step being less than 24 inches in width. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts. Excavated material shall be recompacted along with new embankment material. The cost for benching and recompacting shall be included in the price bid for other items.

Whenever the finished subgrade lies within 3 feet of an existing compacted roadway with an aggregate or bituminous surface, the bituminous material shall be removed and the remaining road surface shall be scarified to a depth of at least 6 inches and recompacted to the specified density. The bituminous material shall be disposed of according to Section 203.02 D.

If embankment can only be placed on one side of abutments, wing walls, piers, or culvert headwalls, compaction operations shall be accomplished without placing excessive pressure against the structure. The fill adjacent to the bridge abutment shall not be placed higher than the berm elevation in front of the abutment until the superstructure is in place. When embankment is placed on both sides of a concrete wall or box-type structure, the embankment shall be brought up equally on both sides of the structure.

If the Engineer directs that material to be used in embankment be hauled beyond the average haul limit, it will be measured according to Section 203.03 E and paid as specified in the Price Schedule (PS-1).

Frozen material shall not be used in embankment construction. If frozen excavation or a blanket of snow is encountered, grading operations shall be suspended.

Roadway embankments of earth material shall be placed in horizontal layers not to exceed 12 inches (loose measurement), and shall be compacted to the specified density before the next layer is placed.

Motor graders shall be used on each lift to spread the material and to obtain uniform thickness before compacting. As the compaction of each layer progresses, continuous leveling, disking, and manipulating shall be provided to assure uniform soil distribution, moisture, and density control. Construction equipment shall be routed uniformly over the entire surface of each layer; and, if open to traffic, the embankment shall be maintained so that the public can safely traverse the work area.

When the excavated material consists predominantly of rock too large to be placed in layers of the thickness prescribed, the material may be placed in thicknesses up to the average rock size, but no thicker than 2 feet. Each layer shall be leveled and smoothed by using suitable leveling equipment. The rock fill lifts shall not be constructed above an elevation of 2 feet below the finished subgrade. The balance of the embankment shall be composed of suitable earth placed according to this Section.

When a rock fill is to be placed over any structure, the structure shall first be covered and compacted with a minimum of 2 feet of earth or other approved material before placing rock fill. The bottom 2 feet of a surcharge shall meet the compaction control requirements of the embankment upon which the surcharge will be placed.

- G. Construction of Embankment and Treatment of Cut Areas With Compaction Control, Type A.** All fills, excluding rock fills, 18 inches or less, and cut areas, shall be constructed with moisture and density controls. The requirements of Section 203.02 F also apply to this Section.

The Engineer will determine the maximum dry density and optimum moisture content using AASHTO T 99 or T 180 as shown on the Plans. Both AASHTO T 99 or T 180 may be modified according to the Department's testing procedure.

When the maximum dry density is determined using AASHTO T 99, the moisture content of the soil at the time of compaction shall be not less than 4 percentage points below, nor more than 5 percentage points above the optimum moisture content. The embankment and cut areas designated to be excavated and recompacted shall be compacted to a minimum of 95 percent of the maximum dry density, as determined by AASHTO T 99.

When the maximum dry density is determined using AASHTO T 180, the moisture content of the soil at the time of compaction shall be not less than the optimum moisture content and no more than 5 percentage points above the optimum moisture. The embankment and the cut areas designated to be excavated and recompacted shall be compacted to 90 percent of the maximum dry density as determined by AASHTO T 180.

If the subgrade is unstable (as evidenced by sponginess or rutting), the soil shall be dried to the required density. The cost of such drying shall be included in the bid

items “Common Excavation” and “Borrow Excavation.” The soil shall be worked so that the moisture content is uniform throughout.

Private drives, minor road approaches, and other parts of the embankment outside the roadbed shall be compacted as directed by the Engineer.

In the construction of a surcharge, no specified density is required.

- H. **Construction of Embankment and Treatment of Cut Areas with Compaction Control, Type B.** Except for rock fills and the first layer of fills over swampy ground, embankment materials shall be deposited in layers not exceeding 12 inches in thickness before compaction. The requirements of Section 203.02 F also apply to this section.

Each layer shall be uniformly compacted by operating grading equipment and rollers over the entire area. Tamping rollers shall be operated over each layer until the Engineer is satisfied with the depth of penetration of the tamping feet. The compaction of each layer of embankment material shall be thorough and uniform. The tamping feet of tamping rollers shall exert a ground pressure of at least 250 psi.

If the Engineer determines that the soil is too dry to secure compaction, water shall be applied to each layer before compacting.

Embankment material that is too wet to secure compaction and stability shall be dried or allowed to dry so the desired compaction can be obtained, and worked so the moisture content is uniform throughout.

Dumping and rolling areas shall be kept separate, and no lift shall be covered by another until the specified compaction is secured.

- I. **Construction of Type C Embankment.** Except for rock fills and the first layers of fills over swampy ground, embankment material shall be spread in horizontal layers not exceeding 8 inches in thickness (loose measurement) over the full width of the proposed embankment section. No compaction other than that obtained by passage of the construction equipment over the work is required. The construction equipment shall be routed uniformly over the entire area of each layer. The addition of water or drying of fill material is required when directed by the Engineer. The requirements of Section 203.02 F also apply to this Section.
- J. **Haul.** Haul consists of transporting excavation material from its original location to its final location in the work.
1. Average haul is the average distance in stations which all excavation in excess of that deposited within the station must be hauled.
 2. Free-haul distance is the specified distance excavated material shall be hauled without additional compensation. The free-haul distance is defined as the average haul for the Project.
 3. Overhaul consists of authorized hauling in excess of the free-haul distance, if the haul is also beyond the designated balance points.

The various items of work under the general heading of Earthwork includes all haul and no allowance will be made for Overhaul, except as follows:

The Contractor shall not haul across balance points without approval from the Engineer. If material is hauled across balance points without the Engineer's consent, no allowances for overhaul will be made.

Whenever the quantity of Excavation within balance points or divisions is insufficient to make the required embankment, and no borrow excavation is specified to make up deficiencies, the Engineer may require the Contractor to secure additional excavation outside the balance division within the limits of the Right of Way. Such material will be measured and paid for under the pertinent classifications included in the Contract as set forth under Section 200, and all transportation and haul on such material in excess of the average haul for the Project will be classed as Overhaul.

- K. **Finishing.** Excavation and embankment work, including borrow areas, shall be finished true to grade and cross section. The backslopes and ditches shall be kept finished as construction progresses.

The Contractor shall conduct operations so the distance between the point where the old road surface is disturbed or excavation begins, to where the roadbed is finished to grade and aggregate is placed does not exceed 3 miles for each active grading operation. Provisions for the safety and convenience of the traveling public shall be made on roads kept open to traffic.

- L. **Provision for Traffic Maintenance.** Temporary stockpiles of traffic service gravel shall be placed where specified or as directed by the Engineer. These stockpiles shall be used to provide a temporary surface to aid traffic flow through construction areas during wet and muddy conditions and during other periods when construction operations are suspended. Grading operations on the existing roadbed shall not be started until the temporary traffic service gravel stockpiles are complete.

Stockpiled traffic service gravel that is not needed for traffic maintenance shall be used as follows:

1. If all the material is the same class of aggregate as specified for the base, it shall be incorporated into the final aggregate course placed on the subgrade.
2. If the material is not the same class of aggregate as specified for the base, it shall be incorporated into the subgrade as directed by the Engineer.

203.03 METHOD OF MEASUREMENT.

- A. **Measured Quantities.** All accepted excavation and borrow shall be measured in its original position by cross-sectioning. Volumes will be computed from the cross-section measurements by the average end area, prismatic, or other acceptable methods.

Authorized excavation of rock, shale, muck, or unsuitable material below grade shall consist of that excavation necessary to provide the designed thickness of backfill. If the plane of the designated bottom of excavation falls within a layer or stratum of rock, the rock to the bottom of the layer, not to exceed 12 inches, will be authorized excavation and measured for payment. Rock excavation more than 12

inches below grade will not be paid for unless authorized by the Engineer. The measurements will include overbreakage in rock excavation from the backslopes to an amount not to exceed 10 percent of the actual quantity.

When unexpected rock excavation or shale is encountered, the Contractor shall notify the Engineer. The Contractor's operations shall be conducted so the rock or shale excavation quantity can be readily measurable. If this is not done, the entire quantity of material will be paid for as Common Excavation.

Unsuitable materials, excavated and removed to obtain proper compaction in cut sections and in foundations for fill sections, will be measured for payment.

Where it is impractical to measure material by the cross section method due to the erratic location of isolated deposits, acceptable methods involving 3 dimensional measurements may be used.

- B. **Contract Quantity Payment.** When specified on the Plans, the quantities of excavation to be paid will be those shown in the Contract, provided the Project is constructed to the lines and grades shown on the Plans.

When disagreement exists between the Contractor and the Engineer as to the accuracy of the Plan quantities in any balance or the entire Project, either party may request that the quantities be measured. Additional original cross sections may be interpolated at points where necessary to more accurately determine the quantities.

- C. **Borrow Excavation.** Borrow excavation will be measured and paid for by the Cubic Yard or Ton according to Section 109.01.
- D. **Water.** When payment for Water is specified, Water used will be measured according to Section 216.05.

When Water is not specified as a pay item in the Contract, Water used will be included in the other items of work.

- E. **Haul.** Authorized haul will be based on depositing the excavated material in the adjacent embankment which is the minimum possible distance. The haul distance for material obtained from the roadway and placed inside the roadway shall be measured along the centerline of the roadway. The haul distance for material moved from outside the roadway shall be measured along the shortest route determined by the Engineer.

1. **Authorized Haul.** Haul will be the product obtained by multiplying the number of units of excavation removed from its original position, by the mean distance such excavation is hauled. The distance between the center of gravity of the excavation and the center of gravity of the embankment will be the haul distance in the units specified.

$$\text{Haul} = \text{Unit of Excavation} \times \text{Mean Haul Distance}$$

2. **Average Haul.** The average haul will be determined from the mass diagram. The area of the mass diagram representing the number of cubic yard stations of haul between the balance points will be divided by the ordinate of the mass which is the yardage hauled. The resulting quotient is the average haul.

Average Haul.

$$\text{Average Haul (in Sta.)} = \frac{\text{C.Y. Sta. of Haul}}{\text{C.Y. Hauled}}$$

3. **Overhaul.** The limit of free-haul will be determined from a mass 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, such that the distance between them equals the free-haul distance, and the included quantity of excavation and embankment are in balance. All materials within the free-haul limit will be eliminated from further consideration. The distance between the center of gravity of the remaining mass of excavation and the remaining mass of embankment minus the free-haul distance, will be the overhaul distance. The quantity of overhaul is the product of the overhaul distance multiplied by the number of units of material hauled in excess of the free-haul distance. Analytical methods may be used for computing overhaul in lieu of the mass diagram method described herein.

The Engineer will determine the necessity for overhaul and shall be afforded six hours before and after hauling operations to take the necessary cross sections and measurements to determine the volume of overhaul excavation.

Overhaul: Distances will be shown in stations.

$$\text{Overhaul Distance} = (\text{Distance between centers of gravity}) - (\text{Free Haul Distance}^*)$$

*Free Haul Distance = Average Haul for the Project.

- F. **Obliteration.** Roadway obliteration will be measured in Linear Feet of roadway or in Cubic Yards.
- G. **Topsoil.** Topsoil from excavation, embankment, and borrow areas will be measured by the Cubic Yard. The contract quantity of topsoil may be paid if the Engineer determines that the topsoil within the construction limits has been removed and to the required depth. Any changes in the topsoil removal areas will require measurement.
- H. **Embankment.** Embankment will be measured under Section 203.03 A except the original cross sections will be taken after topsoil is removed from the embankment area. Final cross sections will be taken after the embankment is placed and before the topsoil is replaced.
- I. **Guardrail Embankment, Type C.** Guardrail Embankment, Type C will be measured as a unit at each location, complete and in place.
- J. **Urban Project Provisions.** The back side of curb and gutter is the outer limit for measurement of Common Excavation pay quantity. Where the sidewalk is adjacent to the curb and gutter, the outer limit for measurement of the Common Excavation is the outer edge of the sidewalk.

Costs for the disposal of excess excavation from the trenches of storm drains, water lines, water mains, sanitary sewers, and related items will be included in the price bid for the respective pay item.

Excess excavation and old concrete sidewalks, driveways, curb and gutter, pavement, bituminous surfacing, etc., shall be disposed of off the Right of Way at a site selected by the Contractor and acceptable to the Engineer. Disposal in wetland areas will not be allowed. The cost of disposal (and obtaining of the disposal area) will be included in the price bid for other items.

K. **Seeding.** Seeding and Topsoil for Type C Seeding will be measured and paid for under Sections 708.02 D and 708.02 E.

203.04 BASIS OF PAYMENT.

When there is no Contract item for rock or shale excavation, they will be paid for at the rate specified in the Proposal Price Schedule (PS-1).

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Common Excavation Type A	Cubic Yard
Common Excavation Type B	Cubic Yard
Common Excavation Type C	Cubic Yard
Topsoil	Cubic Yard
Rock Excavation	Cubic Yard
Muck Excavation	Cubic Yard
Shale Excavation	Cubic Yard
Borrow Excavation	Cubic Yard or Ton
Water	M Gal (1,000 Gallons)
Roadway Obliteration	Linear Feet, Cubic Yard
Embankment	Cubic Yard
Guardrail Embankment, Type C	Each

Payment will be made under:

Pay Item	Unit of Quantity	Units of Distance	Pay Units
Overhaul	Cubic Yard	Stations of 100 ft.	Cubic Yard Stations

The item of average haul will not be paid directly, as it is included in the other earth-work items.

Haul items will not be measured and paid if the material can be secured and used as shown on the Plans. If the Engineer directs hauling of materials beyond the specified or average haul limits, haul will be paid at the rate specified in the Price Schedule (PS-1).

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

**SECTION 210
STRUCTURAL EXCAVATION, STRUCTURAL
FILL, AND FOUNDATION PREPARATION**

210.01 DESCRIPTION.

Structural Excavation consists of the excavation and ordinary backfill required for installation of box culverts and bridges.

Structural Fill shall consist of furnishing and placing select backfill material as shown on the Plans or as otherwise directed.

Foundation Preparation consists of site preparation for installation of a box culvert or bridge.

210.02 MATERIALS.

A. **Ordinary Backfill.** Material for ordinary backfill shall be approved compactible soil selected from structure excavation. Any additional material needed shall be approved material obtained from borrow excavation.

B. Structural Fill.

1. **Select Backfill.** Select backfill shall be a well-graded mixture of stone fragments or gravel, coarse sand, and fine sand, excluding scoria and shale. Maximum size and gradation shall be as specified.
2. **Foundation Fill.** Foundation fill material shall be CL 3 or CL 5 as specified in Section 816, unless otherwise noted.

210.03 CONSTRUCTION REQUIREMENTS.

The excavating, shoring, cofferdamming, sealing, and pumping for box culverts and bridges shall be done so the concrete is placed in a dry area free from standing or flowing water.

When a footing is placed on an excavated surface, the bottom of the excavation shall not be disturbed. If disturbed, the area shall be scarified and recompact with a mechanical tamper. Final preparation of the foundation bed shall be made just before concrete placement. When foundation piles are used, the bottom of the excavation may extend below the bottom of the footing to allow for heaving and placing backfill after the piles are driven. This extra excavation and backfill shall be at the Contractor's expense.

All suitable excavated material shall be used for backfilling, and the balance shall be stockpiled or disposed of at locations acceptable to the Engineer. All unsuitable material shall be disposed of and paid for according to Section 203.02 D.

After the unsuitable material has been excavated, foundation fill shall be placed in 6-inch maximum layers to the required elevation. Each layer shall be thoroughly compacted with mechanical tamping equipment. Water may be required to achieve satisfactory compaction and stability.

Backfill shall not be placed to a higher elevation on one side than on the other side of a wall until the concrete has attained at least 70 percent of its design strength. If a wall depends on a superstructure for support, backfill shall not be placed until the falsework for the superstructure has been released. Concrete box culverts shall not be backfilled until the concrete has attained at least 70 percent of its design strength.

When there are separate structural and grading contracts, the Structural Contractor shall backfill box culverts to an elevation of 2 feet above the top of the box culvert, and

shall backfill bridges to the elevation shown on the Plans. The horizontal limits of the backfill shall be as shown on the Plans. The Grading Contractor shall complete the remaining backfill in conjunction with grading operations.

When a specified density is required, backfill shall be placed in horizontal layers not exceeding 12 inches loose measurement and be uniformly compacted with mechanical tamping equipment to the specified density.

In non-load carrying areas where specified density is not required, the backfill shall be placed in layers of not more than 6 inches, moistened or dried as required, and thoroughly compacted with mechanical tamping equipment.

Special care shall be taken to prevent any wedging action against the structure. The use of drop pile hammers, loaded or unloaded clam shells, or other similar equipment is prohibited for compacting backfill.

Backfill material deposited in water or adjacent to piers within the waterway shall be deposited and compacted in a manner acceptable to the Engineer.

Sheet piling, bracing, forms, and rubbish shall be removed from the excavation before the backfill is started.

210.04 METHOD OF MEASUREMENT.

A. **Structural Excavation.** The unit of measure will be either by Cubic Yard or Lump Sum, as specified on the Plans.

1. **Channel Excavation.** All excavation designated on the Plans as channel excavation, including the excavation necessary to place riprap and aggregate cushion, and excavation necessary to flatten and shape the slopes to and beyond the abutment locations.
2. **Class Excavation.** When Class 1 or Class 2 Excavation is measured and paid for by the Cubic Yard, the volume to be paid for will be that volume bounded by vertical planes located at either 1-1/2 feet outside of the footing, or 2-1/2 feet outside of and parallel to the wall, whichever is greater, and the following:
 - a. Class 1 Excavation. All excavation above the datum line and outside the limits of channel excavation, as designated on the Plans.
 - b. Class 2 Excavation. All excavation below the datum line and outside the limits of channel excavation, as designated on the Plans.

B. **Foundation Preparation.** The Unit of Measure will be Each for each structural site and, unless specified as separate pay items, will include the cost of performing the following work items:

- Clearing and Grubbing
- Excavation
- Removal of Old Structures (or parts thereof as required)
- Construction and Removal of Shoring, Cribs, Cofferdams
- Dewatering the Excavation

- Concrete Seal
- Backfilling
- Disposal of Surplus Material

Dewatering consists of removing water as needed to facilitate construction, and may require intermittent or continuous operation of pumping equipment until the affected construction activities in the dewatered area are completed.

Excavation shall include Channel Excavation, Class 1 Excavation, and Class 2 Excavation unless these are specified as separate bid items.

C. Structural Fill.

1. **Ordinary Backfill.** Ordinary backfill will not be measured and the costs shall be included in the bid item "Excavation."
2. **Select Backfill.** This item will be measured by the Cubic Yard in place. This measured volume will be increased by 25 percent to allow for shrinkage and to obtain the pay quantity. When select backfill is placed beyond the excavation limits, the pay quantity will be determined by computation using plan dimensions and adding 25 percent for shrinkage.
3. **Foundation Fill.** This item will be measured by the Cubic Yard in place. The measured volume will be increased by 25 percent to allow for shrinkage and to obtain the pay quantity.

210.05 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Channel Excavation	Lump Sum, Cubic Yard
Class 1 Excavation	Lump Sum, Cubic Yard
Class 2 Excavation	Lump Sum, Cubic Yard
Foundation Preparation	Each
Foundation Fill	Cubic Yard
Select Backfill	Cubic Yard

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

**SECTION 216
WATER**

216.01 DESCRIPTION.

This item consists of applying water to materials being incorporated into construction of items covered by the Contract.

Provisions of this Specification shall not apply to Portland Cement mixing water or for watering seeded or sodded areas.

216.02 MATERIALS.

Water shall be furnished by the Contractor and shall be free of any material which impedes its flow through the spraying device.

216.03 EQUIPMENT.

Equipment shall meet Section 151.03 A. Hauling units shall not exceed their licensed legal weight limits.

216.04 CONSTRUCTION REQUIREMENTS.

Water shall be applied to the embankment, to construction materials on the roadbed, to haul roads, and to plant sites in sufficient quantity to secure and maintain proper moisture content or dust control.

216.05 METHOD OF MEASUREMENT.

Water will be measured in units of "M" Gallons (1,000 gallons). Water may be measured in calibrated tanks, by weighing and converting to gallons at the rate of 8.33 pounds per gallon, or by an approved metering device placed in the supply line. The metering device shall be calibrated before use on the Project.

216.06 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Water	M. Gal.

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

**SECTION 230
RESHAPING ROADWAY AND SUBGRADE PREPARATION**

230.01 DESCRIPTION.

This work consists of scarifying, shaping, compacting, and maintaining the subgrade, or reshaping an existing roadway before constructing a base, or surface course.

230.02 CONSTRUCTION REQUIREMENTS.

A. Reshaping Roadway, Shoulders, and Inslopes.

1. **Reshaping Roadway.** All sod shall be removed from that portion of the existing roadbed and slopes between the shoulder lines of the completed roadbed. The roadway, ditches, and slopes shall be reshaped to an elevation and cross section that meets the typical section shown on the Plan.

All soft and spongy material, rocks larger than 4 inches, roots and other foreign matter brought to the surface shall be removed and disposed of under Section 203.02 D. All holes and depressions shall be filled and compacted with approved material.

The subgrade shall be smooth, moistened or dried as necessary, and compacted as specified. Any defects in the subgrade shall be corrected according to these Specifications.

2. **Shoulder Preparation.** When included as a separate bid item, "Shoulder Preparation" consists of preparing the existing shoulders to receive a base or surface course. All weeds, grass, dirt, and other objectionable material shall be removed from the shoulders by blading, power brooms, or other means approved by the Engineer. Sod chunks or pieces of debris larger than 36 square inches on any face shall be disposed of under Section 203.02 D.
3. **Reshaping Inslopes.** When shown as a separate bid item, "Reshaping Inslopes" consists of reshaping existing inslopes to form a smooth transition between the finished shoulder and the existing inslope.
4. **Topsoil.** Topsoil shall be removed from inslopes and other seeded areas where reshaping will take place, and shall be stockpiled on the Right of Way or other locations acceptable to the Engineer. Salvaged topsoil that is stockpiled within the clear zone must be stockpiled in a manner that is safely traversable. The stockpile must have slopes which are 4:1 or flatter if they are located within the clear zone. Topsoil shall be replaced according to Section 203.02 B.

On divided highways, topsoil removed from median inslopes shall be stockpiled at locations shown on the Plans or acceptable to the Engineer.

B. Subgrade Preparation.

1. **General Requirements.**

The subgrade shall be scarified, shaped, and compacted to the depth specified in the Plans, prior to the placement of the base section.

The subgrade shall be scarified with the use of a plow and disk to provide a uniform section. The plow and disk shall conform to the requirement of Section 151. Rocks which interfere with trimming the subgrade, the subgrade material, roots, and foreign material brought to the surface, shall be disposed of under Section 203.02 D.

The moisture and density requirements will be specified in the Plans. If the specified density and stability cannot be obtained by manipulating and drying because of excessive moisture, work shall be suspended to allow the subgrade to recover its strength. No additional payments shall be made to the

Contractor due to the suspension of work. If the Engineer directs manipulation and drying below the depth specified in the Plans, payment will be made according to Section 104.03.

The subgrade shall be compacted in 6-inch lifts to the depth of specified subgrade preparation. Special requirements for moisture density control will be noted in the Plans.

The subgrade elevations shall not vary from any point by more than 0.08 foot from the prescribed elevation.

The Contractor shall maintain the subgrade and take the necessary precautions to protect the finished subgrade from damage. The Contractor shall ensure that the subgrade has been graded to drain at the end of each day. The routing of traffic over the finished subgrade shall be limited to that which is essential for construction purposes. Any damage resulting from construction operations shall be repaired at the expense of the Contractor.

Base or surface material shall not be placed until the subgrade has been checked and approved by the Engineer. The subgrade shall have the required stability and compaction during placement. No rutting or displacement of the roadbed shall occur when the base material is placed on the subgrade.

The Department will set appropriate stakes for use in shaping the subgrade to the required section and the established grade. The Contractor shall preserve the line and grade stakes as long as they are needed.

Private drives, minor road approaches, and areas of irregular dimension or restricted access shall be shaped and compacted to the required stability with no specified density.

2. **Subgrade Preparation Type A.** This work shall meet Section 230.02 B.1.
3. **Subgrade Preparation Type B.** This work shall meet Section 230.02 B.1 and the following:

Special requirements for moisture and density control will be noted on the Plans.

Before placing any base or surfacing material on the roadbed, the subgrade shall be brought to the required grade and cross section using a roadbed planer conforming to Section 153.06. Grade control will be taken from the taut string line erected parallel to the established grade line, except the Engineer may permit a base or surface course to be used as a grade reference for trimming the shoulders. Taut string lines shall be erected and maintained for operating the automatic controls on the trimming equipment.

4. **Subgrade Preparation Type A (Shoulders).** When included as a separate bid item, "Subgrade Preparation Type A (Shoulders)" consists of removing some or all of the existing base and surfacing from the shoulders, reshaping and recompacting the shoulder subgrade; and replacing and recompacting some or all of the base or surface material removed. Specific requirements will be as shown on the Plans.

- 5. **Subgrade Preparation Type C.** This work shall meet Section 230.02 B. 1 and the following:

Special requirements for moisture and density control will be noted on the Plans.

Before placing any base or surfacing material on the roadbed, the subgrade shall be brought to the required grade and cross section using trimming equipment outfitted with automatic control of the cutting edge.

- 6. **Aggregate for Subgrade Repair.** Aggregate for subgrade repair shall be specified in the Plans and meet the corresponding requirements of Section 816.03.

230.03 METHOD OF MEASUREMENT.

- A. **Reshaping Roadway.** Reshaping roadway will be measured by the Mile or Station of reshaped roadway.
- B. **Shoulder Preparation.** Shoulder preparation will be measured by the Miles or Stations of shoulder prepared as specified. Each shoulder will be measured separately.
- C. **Reshaping Inslopes.** Inslopes that have been reshaped as specified will be measured by the Miles or Stations. Inslopes on each side of the roadway will be measured separately.
- D. **Subgrade Preparation.** The quantity of Type A, Type B, Type C (12 inches), or Type C (18 inches) Subgrade Preparation will be the number of Miles or Stations prepared and accepted, measured along the centerline of the road. Areas outside the roadbed, such as private drives, road approaches, road tapers, and ramps will not be measured for payment but will be considered part of the mainline measurements.
- E. **Subgrade Preparation Type A (Shoulders).** Shoulder subgrade preparation will be measured by the Miles or Stations of subgrade preparation completed and accepted. Each shoulder will be measured separately.
- F. **Water.** The quantity of Water used will be measured under Section 216.05.
- G. **Topsoil.** Topsoil will not be measured for payment.
- H. **Aggregate of Subgrade Repair.** Aggregate will be measured by the Ton or Cubic Yard as specified. Unit price will include providing, hauling, placing, and compacting the material.

230.04 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Reshaping Roadway	Mile or Station

Subgrade Preparation Type A	Mile or Station
Subgrade Preparation Type B	Mile or Station
Subgrade Preparation Type C (12 inches)	Mile or Station
Subgrade Preparation Type C (18 inches)	Mile or Station
Shoulder Preparation	Mile or Station
Reshaping Inslopes	Mile or Station
Subgrade Preparation Type A (Shoulders)	Mile or Station
Aggregate for Subgrade Repair	Ton or Cubic Yard
Water	M. Gal.

Full compensation for excavation, removal, and disposal of undesirable subgrade material will be paid according to Section 104.03.

Excavation and hauling of material from one point to another on the roadbed to adjust the grade line will be paid according to Section 104.03.

The cost of removing, stockpiling, and replacing topsoil along the reshaped inslopes will be included in the prices bid for the reshaping and subgrade preparation items.

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

**SECTION 234
STABILIZED SUBGRADE**

234.01 DESCRIPTION.

This work consists of treating the top layer of subgrade with lime or lime-fly ash.

234.02 MATERIALS.

Materials shall meet the following:

Item	Section
Lime	804.02
Fly Ash	820
Water	812

234.03 EQUIPMENT.

Equipment shall meet the following:

Item	Section
General	151.01
Water-Hauling Equipment	151.03 A
Material Hauling Equipment	151.03 B
Tow-Type Pneumatic-Tired Rollers	151.02 A
Self-Propelled Pneumatic-Tired Rollers	151.02 B

234.04 CONSTRUCTION REQUIREMENTS.

The roadbed shall be shaped to the cross section shown on the Plans. The roadbed material shall be scarified or disked to a depth of 6 inches, 12 inches, 18 inches, 24 inches, or more as required. Any work that the Engineer requires to be done below a 24-inch depth will be paid according to Section 104.03. The bottom 6 inches of the scarified or disked depth shall remain on the roadway, mixed with lime, and worked in place. The subgrade shall be replaced in 6-inch lifts, aerated, mixed with lime or lime-fly ash, and recompact as directed by the Engineer. Section 104.03 B will not apply to lime or lime-fly ash. Any wet or unstable materials below the scarified section shall be corrected as directed by the Engineer.

- A. **Spreading.** The lime or lime-fly ash shall be spread by dry application or slurry at the rates shown on the Plans. The lime and fly ash may be applied together or separately, provided the lime is applied before the fly ash. Both lime and fly ash shall be distributed uniformly without loss of material by wind or other causes. Lime or fly ash shall not be applied by dry application when the wind is 15 mph or greater.

Slurry shall be used in areas adjacent to residential or other developed areas so the lime or lime-fly ash does not damage, discomfort, or be an inconvenience to public or private property. The lime or lime-fly ash shall be premixed with water in approved agitating equipment in proportions so that the "Dry-Solids Content" is at least 30 percent by weight. Lime or lime-fly ash and water may be similarly proportioned in distributing equipment, provided the equipment contains approved metering devices which accurately meters the quantity of water, lime, or lime-fly ash into the distributing tank to provide positive controls for proper proportioning of the mixture.

All distributing equipment shall provide continuous and adequate agitation until the slurry is applied to the roadbed. The slurry shall be applied through pressurized distributing spray bars. Adequate means of accurately determining distribution of lime or lime-fly ash on each area shall be provided. Each distributing unit shall be provided with a metering device which accurately determine the "Dry-Solids Content" applied to any area, based on the percentage of lime or lime-fly ash in the slurry. The application of lime or lime-fly ash may also be controlled by weight or by measuring and converting to weight each load or partial load applied, and basing the dry-solids content on the percentage of lime or lime-fly ash in the slurry.

The total application of lime or lime-fly ash ordered shall be attained by successive passes of the distributing equipment over a measured area.

The slurry may be applied directly to the scarified or disked subgrade, provided no loss of lime or lime-fly ash slurry is evident and uniform distribution into the soil can be made.

- B. **Mixing.** The lime or lime-fly ash shall be thoroughly mixed with the material to be processed with enough water added to the mixture to maintain not less than optimum moisture content. Mixing shall be accomplished by the use of a rotary mixer. It shall be mixed so that 100 percent of the material passes a one inch sieve. If the material does not readily mix with the lime or lime-fly ash, it shall be thoroughly mixed, brought to the proper moisture content, and left to cure 24 to 48 hours.

- C. **Compacting and Finishing.** Compaction shall begin immediately after the material has been spread to the specified section. The stabilized subgrade shall be compacted to the density specified in the Plans.

If 6 inches are scarified or disked, the 6 inches shall be compacted until a uniform specified density is obtained. If more than 6 inches are scarified or disked, the top 12 inches shall be compacted until a uniform specified density is obtained.

Subgrade material that can not be compacted to the required stability shall be removed and replaced with approved material. Rocks, roots, and any other material that may interfere with compaction and shaping to grade and cross section shall be removed and disposed of under Section 203.02 D. If the required stability cannot be achieved through manipulation and drying after the subgrade is scarified to the required depth, the Engineer will determine what further subgrade work is necessary.

When imprints from equipment are left in the finished surface, the surface shall be lightly scarified and recompact. The moisture content of the surface material must be maintained at its specified optimum during all finishing operations.

The Engineer may suspend the work if instability of the subgrade is caused by frost or excess moisture. A suspension for these reasons shall not constitute a basis for a claim for payment of any Contractor losses.

Mixing shall not be performed after October 1 and shall not be resumed in the spring until the ground is frost free.

- D. **Curing.** The completed surface of the treated subgrade shall be kept in a continuously moist condition until an application of bitumen is applied to the surface as a protective cover to prevent moisture loss.

Liquid Asphalt for curing shall be applied according to Section 401.

234.05 METHOD OF MEASUREMENT.

- A. **Lime or Lime-Fly Ash Treated Subgrade.** Lime Treated Subgrade or Lime-Fly Ash Treated Subgrade will be measured by the Square Yard or Mile. At any given area, only one of the Treated Subgrade bid items will be paid, unless a second depth is specified by the Engineer. When a second depth of treatment is ordered, payment will be made for both the first and the second depth of "Lime or Lime-Fly Ash Treated Subgrade" at the price bid.

Cost associated with scarification and recompaction of the subgrade will not be paid separately but shall be included in the price bid for "Lime or Lime-Fly Ash Treated Subgrade."

- B. **Lime.** Lime will be measured by the Ton.
- C. **Water.** Water will be measured under Section 216.
- D. **Liquid Asphalt.** Liquid Asphalt will be measured under Section 109.
- E. **Fly Ash.** Fly Ash will be measured by the Ton.

234.06 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Lime Treated Subgrade ____ inches	Square Yard or Mile
Lime-Fly Ash Treated Subgrade ____ inches	Square Yard or Mile
Hydrated Lime	Ton
Fly Ash	Ton
Water	M. Gallons
Liquid Asphalt for Curing	Gallons

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

SECTION 300
BASES

SECTION 302
SALVAGED BASE COURSE, AGGREGATE BASE COURSE,
OR AGGREGATE SURFACE COURSE

- 302.01 DESCRIPTION
- 302.02 MATERIALS
 - A. Aggregate or Salvaged Material
 - B. Acceptance
- 302.03 EQUIPMENT
- 302.04 CONSTRUCTION REQUIREMENTS
 - A. Pit Operations
 - B. Subgrade Preparation
 - C. Depositing and Laydown
 - D. Compaction
 - E. Application of Water
 - F. Surface Tolerance
 - G. Limitations
 - H. Maintenance of Completed Course
- 302.05 METHOD OF MEASUREMENT
- 302.06 BASIS OF PAYMENT

SECTION 304
PERMEABLE STABILIZED BASE COURSE

- 304.01 DESCRIPTION
- 304.02 MATERIALS
 - A. Aggregate
 - B. Acceptance
 - C. Asphalt
 - D. Portland Cement
- 304.03 EQUIPMENT
- 304.04 CONSTRUCTION REQUIREMENTS
 - A. General
 - 1. Subbase
 - 2. Finished Surface
 - 3. Traffic
 - 4. Pavement Edge
 - 5. Placement
 - 6. Tolerance in Base Thickness
 - B. Asphalt Stabilized Base
 - 1. Material Production and Placement
 - 2. Compaction
 - 3. Weather Limitations
 - C. Portland Cement Treated Base
 - 1. Material Production
 - 2. Placement
- 304.05 METHOD OF MEASUREMENT
- 304.06 BASIS OF PAYMENT

SECTION 306
BLENDED BASE COURSE

- 306.01 DESCRIPTION
- 306.02 MATERIALS
 - A. Blended Material
 - B. Aggregate
 - C. Acceptance
 - 1. Aggregate
- 306.03 EQUIPMENT
- 306.04 CONSTRUCTION REQUIREMENTS
 - A. Pit Operations
 - B. Adding Corrective Material
 - C. Aggregate Placement and Blending
 - D. Blending Depth
 - E. Placement and Compaction of Blended Material
 - F. Soft Areas
 - G. Application of Water
 - H. Surface Tolerance
 - I. Limitations
 - J. Maintenance of Completed Courses
- 306.05 METHOD OF MEASUREMENT
 - A. Blended Base Course
 - B. Remove and Relay Blended Base Course
 - C. Aggregate
 - D. Water
- 306.06 BASIS OF PAYMENT

SECTION 302
SALVAGED BASE COURSE, AGGREGATE BASE COURSE,
OR AGGREGATE SURFACE COURSE

302.01 DESCRIPTION.

This work consists of furnishing and placing one or more courses of aggregate or salvaged materials on a prepared foundation.

302.02 MATERIALS.

A. **Aggregate or Salvaged Material.** Aggregates shall meet Section 816 for the class of aggregate specified. Salvaged material shall meet the specifications of Section 817.

B. **Acceptance.** Refer to the Department's *Field Sampling and Testing Manual*.

1. **Aggregate Base.** When the aggregate does not meet the gradation specified for all required samples, a reduction in the Contract Unit Price will be made. If the aggregate fails to meet the specified gradation on one or more sieves, the reduction will be the sum of the deductions as calculated below.

Unit Price Reduction: Percent of Deduction = $5 \times$ percent of deviation from range limits.

If material is produced that deviates from the specified gradation for 2 consecutive lots, incorporation of additional material into the work will not be allowed until the Contractor takes the necessary corrective action to meet the specifications.

2. **Salvaged Base.** If the average exceeds the specified limits for shale, the unit price for aggregate will be adjusted according to Section 302.06. If the average exceeds the specified limits for plasticity index or fractured faces, the Contractor shall correct the stockpile so the material meets specifications.

Bitumen-content testing of Contractor-supplied Salvaged Base will be performed on lots of 10,000 tons or fraction thereof for the final lot. If the average of the 3 extraction results is greater than 3.5 percent, a reduction in the unit price will be made according to the formula below. If the average percentage of bitumen exceeds 4.0 percent, the material will be rejected.

Unit Price Reduction:

Percent Reduction = $20 \times$ 0.1 percent above the allowable bitumen content (i.e. a 2 percent reduction per 0.1 percent above the allowable)

When the average of the test results specified in Section 302.02 shows a larger percentage of shale than the maximum allowable specified, a 1 percent reduction

in the unit price will be made for each 0.2 percent above the allowable percentage. If the percentage of shale exceeds the allowable limit by 3 percent or more, the material will be rejected unless the material is accepted under Section 105.07.

302.03 EQUIPMENT.

Equipment shall meet the following:

Item	Section
General	151.01
Tow-Type Pneumatic-Tired Rollers	151.02 A
Self-Propelled Pneumatic-Tired Rollers	151.02 B
Vibratory Rollers	151.02 D
Vibratory Sheeps Foot/Pad Foot/Extended Pad Foot Rollers	151.02 F
Water-Hauling Equipment	151.03 A
Material-Hauling Equipment	151.03 B

302.04 CONSTRUCTION REQUIREMENTS.

- A. **Pit Operations.** Stripping of the pit and pit operations shall be according to Section 106.02 and other Contract requirements to produce an aggregate meeting the specification for the class specified.
- B. **Subgrade Preparation.** Subgrade preparation shall be completed according to Section 230.02 B.
- C. **Depositing and Laydown.** The aggregate shall be deposited, spread, and shaped so the moist and compacted course conforms to the required grade and cross section within the tolerance specified in this Section.
- D. **Compaction.** Compaction shall be carried out simultaneously with laydown operations. The compacted depth of a single course shall not exceed 6 inches. If geotextile fabric is specified, Section 709 will govern compaction requirements. All equipment shall be operated to produce uniform density throughout the entire section. Pneumatic-tired rollers of the type specified in Section 151 shall be used. The desired degree of compaction will be acceptable when the surface is tightly bound and shows no rutting or displacement under roller operation.
- E. **Application of Water.** Water shall be applied according to Section 216 as needed to secure required results.
- F. **Surface Tolerance.** The surface of the completed base shall be tightly bound, smooth, and uniform; and conform to the cross section and grade specified.

Surface tolerance Type A shall be used unless specified.

1. **Surface tolerance Type A.** The finished surface shall not vary from the prescribed cross section elevation by more than 0.08 feet. The longitudinal profile shall not vary by more than 0.08 feet from the grade line established by the Engineer.
2. **Surface Tolerance Type B.** Trimming equipment with automatic grade controls shall be used when surface tolerance Type B is specified. Motor graders

may be used as trimming equipment. The automatic grade controls shall adjust for the cross slope and longitudinal profile. The automatic grade controls shall produce a finished surface that does not vary from the prescribed cross section elevation or grade line by more than 0.04 feet, as established by the Engineer.

3. **Surface Tolerance Type C.** Trimming equipment with automatic grade controls shall be used when surface tolerance Type C is specified. The automatic grade controls shall adjust for the cross slope and longitudinal profile. Motor graders shall not be used as trimming equipment. Roadbed planers shall be used as trimming equipment as specified in Section 153.06. Grade control shall be taken from a taut string line erected parallel to the grade line established by the Engineer. The Engineer may permit a base or surface course to be used as a grade reference for trimming the shoulders. The taut string lines shall be erected and maintained so the automatic controls produce a finished surface that does not vary from the prescribed cross section elevation by more than 0.04 feet from the grade line established by the Engineer.

- G. **Limitations.** The quantity of aggregate or salvaged material permitted in windrows on roadways open to traffic, shall not exceed three miles. The aggregate or salvaged material shall be laid within 72 hours after being placed in the windrow.

Aggregate or salvaged material shall not be placed on a frozen subgrade.

- H. **Maintenance of Completed Courses.** When the Contract includes successive base courses or base and surface courses, each course shall be maintained in a smooth and compacted condition until the succeeding course is placed.

302.05 METHOD OF MEASUREMENT.

- A. **Aggregate or Salvaged Base or Surface Course.** Measurement will be by the Ton or Cubic Yard, as specified.
- B. **Water.** Measurement will be made according to Section 216.

302.06 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Aggregate or Salvaged Base or Surface Course	Ton or Cubic Yard
Water	"M Gal"

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

When a mixture is subject to pay reduction as described in Section 302.02, the Bid Price will be reduced by the sum of the price adjustments.

SECTION 304 PERMEABLE STABILIZED BASE COURSE

304.01 DESCRIPTION.

This work consists of constructing a permeable stabilized base course mixed in a central plant and placed on a prepared subbase. The Contractor shall have the option of using Portland Cement or Asphalt Cement as a stabilizing agent to stabilize the base course.

304.02 MATERIALS.

A. **Aggregate.** The aggregate shall be a Class 7 aggregate as specified in Section 816.03.

B. **Acceptance.** Refer to the Department's *Field Sampling and Testing Manual*.

When the aggregate does not meet the gradation specified, a reduction in the Contract Unit Price will be made. If the aggregate fails to meet the specified gradation on one or more sieves, the reduction will be the sum of the deductions as calculated below.

Unit Price Reduction:

Percent of Deduction = $5 \times$ percent of deviation from range limits.

If material is produced that deviates from the specified gradation for two consecutive lots incorporation of additional material into the work will not be allowed until the Contractor takes the necessary corrective action to meet the specifications.

If the average of three lots exceeds the specified limits for shale, the unit price for aggregate will be adjusted according to Section 302.02. If the average does not meet the specified limits for fractured faces, the Contractor shall correct the stockpile so the material meets specifications.

C. **Asphalt.** The asphalt cement shall be a PG asphalt meeting the requirements of Section 818.02 A.3.

The bitumen shall be added to the aggregate uniformly at a rate of 2-1/2 percent by weight of the mix.

If the daily cutoff for the asphalt cement, as determined on the Mix Bitumen Cutoff Report, deviates from the target percentage specified by more than 0.24 percentage points, the pay factor will be determined as specified in Section 408.05 B.1.

D. **Portland Cement.** The Portland Cement shall meet the requirements of Section 804.01.

The Portland Cement content shall be 200 pounds per cubic yard. Batching of the cement shall be according to Section 802.04 B. Aggregates and bulk cement shall be proportioned by automatic batching equipment according to Section 153.01 B.

304.03 EQUIPMENT.

Equipment shall meet the following:

Item	Section
General	151.01
Rollers	151.02 C
Material Hauling Equipment	151.03 B
Bituminous Pavers	151.04
Scales	151.07
Hot Bituminous Equipment	152
P.C.C. Equipment	153
Roadbed Planer	153.06

304.04 CONSTRUCTION REQUIREMENTS.

A. General.

1. **Subbase.** Before placing the permeable base, the subbase shall be trimmed to the required grade and cross section by a roadbed planer. The finished surface of the subbase shall not vary by more than 0.04 foot from the prescribed elevation.

A prime coat shall be applied to establish an impermeable layer below the permeable base. The prime coat shall be allowed to cure a minimum of 24 hours before the permeable base is placed.

2. **Finished Surface.** The surface of the permeable base shall be smooth and uniform, and shall not vary by more than 0.04 foot from the prescribed elevation. Trimming of the permeable base will not be permitted. Care shall be exercised to prevent contamination of the permeable base. Procedures that might produce fine material that would tend to clog or reduce drainage will not be permitted. Permeable base which, in the opinion of the Engineer, has been contaminated shall be removed and replaced at the Contractor's expense.
3. **Traffic.** Hauling on the permeable base will not be allowed. Traffic over the permeable base will be limited to the minimum necessary for succeeding or adjacent work. Damage to the permeable base shall be repaired promptly at the Contractor's expense.
4. **Pavement Edge.** The outlet edge of the permeable base shall be kept open (daylighted) until the edge drain is placed so that water is free to exit.
5. **Placement.** The permeable base shall be placed in one lift at the specified thickness. The base will be placed with a mechanical spreader, except when placing the base in small areas that are not accessible to large equipment. In these areas the base may be hand placed and compacted with mechanical

hand tampers. The mechanical spreader shall utilize automatic controls with a stringline to control the longitudinal profile.

If approved by the Engineer, the permeable base may be placed without the stabilizing agent in small areas that are formed by hand.

6. **Tolerance in Base Thickness.** Refer to the Department's *Field Sampling and Testing Manual*.

If the permeable base placed has an average thickness in excess of that specified, additional payment will not be made. If the average pavement thickness is deficient by more than 1 inch, the base will be removed and replaced at the Contractors expense. If deficient by less than 1 inch in thickness, price adjustments will be made to the Contract Unit Price for each lot of 4,500 square yards as provided in the following table:

Deficiency in Thickness (Inches)	Pay Factor
0.0 to 0.25	1.00
0.26 to 0.50	0.90
0.51 to 0.75	0.70
0.76 to 1.00	0.50

B. Asphalt Stabilized Base.

- Material Production and Placement.** The permeable base shall be produced at a central hot mix plant according to Section 408.04 E and 408.04 F, paragraph 1. The material produced shall be placed with a bituminous paver.
- Compaction.** Compaction of the permeable base shall be according to Section 302.04 D. except the roller shall be a 10-ton, double drum, steel-wheeled roller. No vibration will be allowed. The Contractor is advised that it may be necessary to permit the permeable base to cool sufficiently before compaction rolling to prevent rutting and shoving. Cooling to 150°F. may be appropriate, but in no case shall the mix be less than 110°F. at time of compaction. Water may not be used to hasten the cooling process.
- Weather Limitations.** Weather limitations shall be as specified in Section 408.04 M.1.

C. Portland Cement Treated Base.

- Material Production.** The Permeable base shall be mixed at a stationary mixing plant capable of producing a uniform mixture and shall be equipped with feeding and/or weighing devices that are capable of proportioning the mixture as specified.

The water/cement ratio shall provide for 100 percent cement (paste) coverage of aggregate. The intent is to add the minimum amount of water to obtain a uniform workable mix.

- Placement.** The cement stabilized base shall be placed with a slip form paver or a mechanical spreader capable of placing the material in one layer. The

paver or spreader shall be equipped with automatic grade control that maintains the proper elevation at both sides by: (1) controlling the elevation of one side and the slope, or (2) controlling the elevation of each side independently. The grade reference shall be an erected string line or other approved method.

The cement stabilized base shall be consolidated with surface pan type vibrators. The frequency of the surface pan type vibrators shall not be less than 4000 impulses per minute, unless modified by the Engineer.

The cement stabilized base shall be allowed to cure a minimum of 48 hours before placement of the surface course. Exceptions may be made, with the Engineer's approval, in areas where immediate access is necessary to accommodate traffic.

Weather limitations shall be as specified in Section 602.03 G.3.

When placing the stabilized base at bridge ends, ramp tapers or other areas where placement is not practical with a mechanical spreader, the base material may be placed with a loader and compacted with a 10 ton steel wheeled roller in the static mode.

304.05 METHOD OF MEASUREMENT.

Permeable Stabilized Base Course. Permeable Stabilized Base shall be measured by the square yard placed, and accepted by the Engineer.

304.06 BASIS OF PAYMENT.

The accepted quantity of permeable stabilized base will be paid for at the contract price bid per square yard. The price shall be full compensation for all materials (including the asphalt or portland cement binder), equipment, labor, and incidentals required to construct this item of work as specified.

Pay Item	Pay Unit
Permeable Stabilized Base Course	Ton or Cubic Yard

SECTION 306 BLENDED BASE COURSE

306.01 DESCRIPTION.

This work consists of blending and placing the existing aggregate base, existing bituminous surfacing and possibly one or more courses of aggregate into a uniform base material.

306.02 MATERIALS.

- A. **Blended Material.** The blended material shall have 97 to 100 percent passing a 2-inch sieve and 90 to 100 percent passing a 1-1/2-inch sieve.

B. **Aggregate.** The aggregate shall meet Section 816 for the class of aggregate specified.

C. **Acceptance.**

1. **Aggregate.** Refer to the Department’s *Field Sampling and Testing Manual* for sampling procedures.

When the aggregate does not meet the gradation specified, a reduction in the Contract Unit Price will be made. If the aggregate fails to meet the specified gradation on 1 or more sieves, the reduction will be the sum of the deductions as calculated below.

Unit Price Reduction:

$$\text{Percent of Deduction} = 5 \times \text{percent of deviation from range limits}$$

If material is produced that deviates from the specified gradation for two consecutive lots incorporation of additional material into the work will not be allowed until the Contractor takes the necessary corrective action to meet the specifications.

If the average of the three samples exceeds the specified limits for shale, the unit price for aggregate will be adjusted according to Section 302.06. If the average exceeds the specified limits for plasticity index or fractured faces, the Contractor shall correct the stockpile so the material meets specifications.

306.03 EQUIPMENT.

Equipment shall meet the following:

Item	Section
General	151.01
Tow-Type Pneumatic-Tired Rollers	151.02 A
Self-Propelled Pneumatic-Tired Rollers	151.02 B
Vibratory Sheeps Foot/Pad Foot/ Extended Pad Foot Rollers	151.02 F
Water-Hauling Equipment	151.03 A
Material-Hauling Equipment	151.03 B
Mining/Blending Machine	151.08

306.04 CONSTRUCTION REQUIREMENTS.

- A. **Pit Operations.** Stripping of the pit and pit operations shall be according to Section 106.02 and other Contract requirements to produce an aggregate meeting the specification for the class specified.
- B. **Adding Corrective Material.** When a combination of materials is required to produce the class of aggregate specified, the aggregate may be blended at the pit or on the road to produce the specified material.
- C. **Aggregate Placement and Blending.** When “Blended Base Course” is specified, the aggregate supplied to be blended with the existing material will be placed and

compacted on the roadway to plan cross slope and to a longitudinal profile approved by the Engineer prior to blending. It is intended for the Contractor to use mining/blending equipment that rides on the existing surface. If the Contractor elects to use equipment that rides on the subgrade, the Contractor shall assure the equipment has sufficient weight distribution to prevent rutting or displacement of the subgrade below the blended material. Any damage caused by the Contractor's equipment riding on the subgrade shall be repaired at the Contractor's expense.

When "Remove and Relay Blended Base Course" is specified, the Contractor may elect to blend the material on or off the roadway. The use of a motor grader to blend the material will not be permitted. The Contractor must prove to the Engineer that the process used to blend the material will provide a uniformly blended base course.

- D. **Blending Depth.** The existing asphalt pavement depth varies. The pavement depths shown in the plans are from cores taken at specified locations. Primed aggregate and bituminous treated base (if present) are not included in the pavement depth. The actual pavement depths at other locations may vary. The Contractor is responsible for interpreting the pavement depths and including all costs in the bid price to process the required depth of existing pavement and existing aggregate.

When "Blended Base Course" is specified, the Contractor shall blend to: the depth shown in the plans or, if the depth shown in the plans is not great enough to process all of the existing surfacing, bituminous treated base (where present), and the existing base, the blending depth shall be increased to the lesser of the following depths:

1. A depth great enough to process all of the supplemental aggregate, existing surfacing and bituminous treated base (where present).
2. A minimum of 18 inches, measured from top of supplemental compacted aggregate. The distance between the existing asphalt material not mined and the new pavement (asphalt or concrete) shall be a minimum of 18 inches.

During the blending operation the Contractor shall physically dig down, approximately every 500 feet (each pass), to check the blending depth and visually verify the full depth of bituminous pavement has been blended without contamination from the subgrade.

When "Remove and Relay Blended Base Course" is specified, and if the Contractor elects to blend the material off the roadway, the entire depth of asphalt pavement shall be removed and blended with the aggregate specified.

- E. **Placement and Compaction of Blended Material.** After blending, the Contractor shall place the blended material as shown in the Plans. The blended material shall be uniform in gradation and compacted to produce a uniform density throughout the entire section. If the material is deficient in moisture content, it shall be moistened to the degree necessary to attain compaction.

Compaction shall be carried out simultaneously with lay down operations. The vibratory sheeps foot/pad foot/extended pad foot roller shall be used to obtain compaction until the feet/pads ride up close to the surface of the blended base. After this, the road top shall be compacted with a pneumatic roller until the surface is

tightly bound and shows no sign of rutting or displacement under the compaction operations or traffic. Vibratory sheeps foot/pad foot/extended pad foot and pneumatic tired rollers of the type specified in Section 151 shall be used.

- F. **Soft Areas.** Unstable areas, as determined by the Engineer, that appear after the blended base has been compacted shall be repaired by the Contractor. If the unstable areas are due to poor compaction of the blended base, the Contractor will rework the blended base to obtain adequate compaction. The cost of reworking the blended base will be included in the item “Blended Base Course.”

If the unstable areas are due to the subgrade, the Engineer may direct manipulation and drying of the subgrade. Payment for this work will be in accordance with Section 104.03 of the Standard Specifications.

- G. **Application of Water.** Water shall be applied according to Section 216 as needed to secure required results.
- H. **Surface Tolerance.** The surface of the completed base shall be tightly bound, smooth, uniform, and conform to the cross section and grade specified. The surface shall be finished using a Surface Tolerance Type B, as specified in Section 302.04 F.
- I. **Limitations.** The quantity of aggregate or blended material permitted in windrows on roadways open to traffic, shall not exceed three miles. The aggregate or blended material shall be laid within 72 hours after being placed in the windrow.

Aggregate or blended material shall not be placed on a frozen subgrade.

- J. **Maintenance of Completed Courses.** When the Contract includes successive base courses or base and surface courses, each course shall be maintained in a smooth and compacted condition until the succeeding course is placed.

306.05 METHOD OF MEASUREMENT.

- A. **Blended Base Course.** Measurement and payment of the bid item “Blended Base Course” will be by the Square Yard based on the width of the existing asphalt pavement from the outside edge of the slough to the outside edge of the slough.
- B. **Remove and Relay Blended Base Course.** Measurement and payment of the bid item “Remove and Relay Blended Base Course” will be by the Ton or Square Yard. When paid by the Square Yard the quantity will be determined by the width of the existing asphalt pavement from the outside edge of the slough to the outside edge of the slough.
- C. **Aggregate.** Measurement will be by the Ton or Cubic Yard, as specified.
- D. **Water.** Measurement will be made according to Section 216.

306.06 BASIS OF PAYMENT.

Payment will be made at the contract Unit Price for the following:

Pay Item	Pay Unit
Aggregate	Ton or Cubic Yard
Water	"M Gal"
Blended Base Course	Square Yard
Remove and Relay Blended Base Course	Square Yard or Ton

This payment will be full compensation all labor, equipment, and materials necessary to complete the work as required.

When a pay reduction, as described in Section 302.02 B, is applicable, the Bid Price will be reduced by the sum of the price adjustments.

SECTION 400
BITUMINOUS PAVEMENTS

**SECTION 401
PRIME, TACK, OR FOG COAT**

- 401.01 DESCRIPTION
- 401.02 MATERIALS
 - A. Bitumen
 - B. Blotter Material
- 401.03 EQUIPMENT
- 401.04 CONSTRUCTION REQUIREMENTS
 - A. Preparation of Surface
 - B. Application of Bitumen
 - C. Application of Blotter Material
 - D. Maintenance and Opening to Traffic
 - E. Limitations
- 401.05 METHOD OF MEASUREMENT
- 401.06 BASIS OF PAYMENT

**SECTION 402
COLD BITUMINOUS PAVEMENT**

- 402.01 DESCRIPTION
- 402.02 MATERIALS
 - A. Bitumen
 - B. Aggregate.
- 402.03 EQUIPMENT
- 402.04 CONSTRUCTION REQUIREMENTS
 - A. Pit Operations
 - B. Conditioning Existing Surface
 - C. Heating of Bitumen
 - D. Hauling and Mixing Aggregates
 - E. Mixing of Aggregates and Bitumen
 - 1. General
 - 2. Blade Mix
 - 3. Traveling Mixer
 - 4. Stationary Plant
 - F. Spreading and Finishing
 - G. Compaction
 - H. Completed Surface
 - I. Maintenance of Completed Surface
 - J. Limitations
- 402.05 METHOD OF MEASUREMENT
- 402.06 BASIS OF PAYMENT

**SECTION 403
STOCKPILED HOT BITUMINOUS MIX**

- 403.01 DESCRIPTION

- 403.02 MATERIALS
 - A. Bitumen
 - B. Aggregate
- 403.03 EQUIPMENT
- 403.04 CONSTRUCTION REQUIREMENTS
 - A. Pit Operations and Stockpiling of Material
 - B. Preparation of Bituminous Material
 - C. Preparation of Aggregate
 - D. Mixing
- 403.05 METHOD OF MEASUREMENT
- 403.06 BASIS OF PAYMENT

SECTION 405
REMOVE AND SALVAGE BITUMINOUS PAVEMENT

- 405.01 DESCRIPTION
- 405.02 CONSTRUCTION REQUIREMENTS
 - A. Prepare Stockpile Site
 - B. Stockpiling
 - C. Restore Stockpile Site
 - D.. Remove and Salvage Bituminous Surfacing
- 405.03 METHOD OF MEASUREMENT
- 405.04 BASIS OF PAYMENT

SECTION 407
HOT RECYCLED BITUMINOUS PAVEMENT

- 407.01 DESCRIPTION
- 407.02 MATERIALS
 - A. Bitumen
 - B. Salvaged Bituminous Material
 - C. Virgin Aggregate
 - D. Recycling Agent
- 407.03 EQUIPMENT
 - A. General
 - B. Recycling Plant
- 407.04 CONSTRUCTION REQUIREMENTS
 - A. Processing Salvaged Material
 - B. Pit Operations and Stockpiling of Aggregate
 - C. Prepare Stockpile Sites
 - D. Stockpiling
 - E. Restore Stockpile Site
 - F. Mix Design

- G. Heating of Bitumen
 - H. Preparation of Virgin Aggregate
 - I. Mixing
 - J. Mix Temperature
 - K. Conditioning Existing Surface
 - L. Spreading and Finishing
 - M. Compaction
 - 1. General
 - 2. Ordinary Compaction
 - 3. Specified Density
 - N. Joints
 - O. Maintaining Completed Course
 - P. Tolerances
 - Q. Limitations
 - 1. Weather
 - 2. Operational
 - R. Bituminous Pavement Sloughs
- 407.05 ACCEPTANCE
- A. Bitumen Content
 - 1. Average
 - 2. Uniformity
 - B. Compaction
 - C. Aggregate
- 407.06 METHOD OF MEASUREMENT
- 407.07 BASIS OF PAYMENT

SECTION 408 HOT BITUMINOUS PAVEMENT

- 408.01 DESCRIPTION
- 408.02 MATERIALS
- A. Bitumen
 - B. Aggregate
- 408.03 EQUIPMENT
- 408.04 CONSTRUCTION REQUIREMENTS
- A. Pit Operations and Stockpiling of Aggregate
 - B. Mix Design
 - C. Heating of Bitumen
 - D. Preparation of Aggregate
 - E. Mixing
 - F. Mix Temperature
 - G. Conditioning Existing Surface
 - H. Spreading and Finishing
 - I. Compaction
 - 1. General
 - 2. Ordinary Compaction
 - 3. Specified Density
 - J. Joints

- K. Maintaining Completed Course
 - L. Tolerances
 - M. Limitations
 - 1. Weather
 - 2. Operational
 - N. Bituminous Pavement Sloughs
 - O. Superpave
- 408.05 ACCEPTANCE
- A. Aggregate
 - 1. Gradation
 - 2. Additional Aggregate Tests
 - B. Bitumen Content
 - 1. Average
 - 2. Uniformity
 - C. Compaction
 - 1. Testing
 - 2. Contractor Coring
 - 3. Compaction Payment Schedule
- 408.06 METHOD OF MEASUREMENT
- 408.07 BASIS OF PAYMENT

SECTION 409
HOT BITUMINOUS PAVEMENT
QUALITY CONTROL/QUALITY ASSURANCE

- 409.01 DESCRIPTION
- 409.02 MATERIALS
- A. Bitumen
 - B. Aggregate
- 409.03 EQUIPMENT
- 409.04 CONSTRUCTION REQUIREMENTS
- A. Pit Operations and Stockpiling of Aggregate
 - B. Mix Design
 - 1. NDDOT-Developed Mix Design
 - 2. Contractor-Developed Mix Design
- (Sections C through N are specified in the respective sections of 408.04.)
- O. Quality Control Sampling and Testing
 - 1. Control Limits
 - 2. Corrective Action
 - 3. Documentation
 - P. Verification Testing
 - Q. Independent Assurance Testing
- 409.05 ACCEPTANCE
- A. Aggregate
 - 1. Gradation
 - 2. Additional Aggregate Tests
 - B. Bitumen Content
 - 1. Average

- 2. Uniformity
- C. Compaction
 - 1. Testing
 - 2. Contractor Coring
 - 3. Compaction Payment Schedule
- D. General
- E. Dispute Resolution Program
- 409.06 METHOD OF MEASUREMENT
- 409.07 BASIS OF PAYMENT

**SECTION 410
HOT BITUMINOUS PAVEMENT
SUPERPAVE VOLUMETRIC MIX DESIGN**

- 410.01 DESCRIPTION
- 410.02 MATERIALS
 - A. Bitumen
 - B. Aggregate
- 410.03 EQUIPMENT
- 410.04 CONSTRUCTION REQUIREMENTS
 - A. Pit Operations and Stockpiling of Aggregate
 - 1. Department-Developed Mix Design
 - 2. Contractor-Developed Mix Design
 - B. Volumetric Mix Design
 - 1. Trail Mix Design/Aggregate Blend Determination
 - 2. Final Mix Design/Job Mix Formula Determination
 - 3. Moisture Sensitivity Test
 - 4. Aggregate/Asphalt Supplied Other Than That Used in the Mix Design

(Sections C through N are specified in the respective sections of 408.04.)

 - O. Quality Control Testing
 - P. Verification Testing
 - Q. Independent Assurance
 - R. Hot Mix Asphalt Sampling
- 410.05 ACCEPTANCE
 - A. Aggregate
 - 1. Gradation
 - 2. Additional Aggregate Tests
 - B. Bitumen Content
 - 1. Average
 - 2. Uniformity
 - C. Compaction
 - 1. Testing
 - 2. Contractor Coring
 - 3. Compaction Payment Schedule
 - D. Verification Testing/Quality Control Testing Tolerances
- 410.06 METHOD OF MEASUREMENT
- 410.07 BASIS OF PAYMENT

SECTION 411
MILLING PAVEMENT SURFACE

- 411.01 DESCRIPTION
- 411.02 EQUIPMENT
- 411.03 CONSTRUCTION REQUIREMENTS
 - A. Milling pavement Surface
 - B. Prepare Stockpile Site
 - C. Stockpiling
 - D. Restore Stockpile Site
- 411.04 METHOD OF MEASUREMENT
- 411.05 BASIS OF PAYMENT

SECTION 420
BITUMINOUS SEAL COAT

- 420.01 DESCRIPTION
- 420.02 MATERIALS
 - A. Bitumen
 - B. Cover Coat Material
 - C. Blotter Material
- 420.03 EQUIPMENT
- 420.04 CONSTRUCTION REQUIREMENTS
 - A. Preparation of Surface
 - B. Application of Bitumen
 - C. Cover Coat Material Application
 - 1. Requirements for Cutback Asphalts
 - 2. Requirements for High Float Emulsified Asphalts
 - 3. Requirements for Cationic Emulsions
 - D. Blotter Material Application
 - E. Protection of Traffic and Preservation of the Seal Coat
 - F. Limitations
 - 1. Weather
 - 2. Operational
- 420.05 METHOD OF MEASUREMENT
- 420.06 BASIS OF PAYMENT

SECTION 401 PRIME, TACK, OR FOG COAT

401.01 DESCRIPTION.

This work consists of preparing and treating a surface with bitumen and blotter material.

401.02 MATERIALS.

A. **Bitumen.** The type and grade of bitumen will be specified in the Contract.

Bitumen shall meet and will be accepted according to Section 818. Bitumen will be conditionally accepted at the Project and sampled according to the Department's procedures in the *Field Sampling and Testing Manual*.

Bituminous materials for the several applications indicated in Section 400 shall be applied within the temperature ranges recommended by the manufacturer.

B. **Blotter Material.** Blotter material shall meet Section 816, Class 44.

401.03 EQUIPMENT.

Equipment shall meet the following:

Item	Section
General	151.01
Self-Propelled Pneumatic-Tired Rollers	151.02 B
Material-Hauling Equipment	151.03 B
Liquid Bitumen Distributors	151.05
Aggregate Spreader	151.06 B
Heating Equipment for Bitumen	152.01

401.04 CONSTRUCTION REQUIREMENTS.

A. **Preparation of Surface.** Before application of bitumen, all broken or unstable surface shall be repaired and compacted and the surface shall be free of any loose dirt and other objectionable material.

Broken or unstable surfaces shall be repaired at the Contractors expense unless the surface was constructed under a previous Contract, then repair costs will be paid according to Section 104.03 or as a Bid Item.

B. **Application of Bitumen.** Bitumen shall be applied with a distributor at the rate specified or as otherwise directed. Hand sprayers shall be used to cover irregular areas or shapes and areas missed by the distributor.

Emulsified asphalt shall be diluted to a 50-50 ratio, unless other approved proportions are directed by the Engineer. Cost of water shall be included in the price bid for "Emulsified Asphalt."

The rate of application and areas to be treated shall be approved by the Engineer prior to application.

When traffic is maintained, the bitumen shall be applied in passes of approximately one-half the width of the completed surface. If the width of the surface makes such application impracticable, the bitumen may be applied in more than two passes. Care shall be taken so the application of bitumen at the junction of passes is not in excess of the specified quantity. Excess bitumen shall be squeegeed from the surface. There shall be an overlap of bitumen along adjoining edges of the passes.

The surface of all structures and other roadway appurtenances shall be protected against splattering. If splattering occurs, all bitumen shall be removed to the satisfaction of the Engineer at the Contractor's expense.

- C. **Application of Blotter Material.** Blotter material shall be applied at the rate designated in the Contract, or the quantity may be increased, decreased, or eliminated as directed by the Engineer to allow for field conditions.

Blotter material shall not be applied until the Engineer has determined that the penetration of bitumen into the surface is adequate, or that no further penetration is probable.

- D. **Maintenance and Opening to Traffic.** Traffic shall not be permitted on the primed, fogged or tacked surface until the bitumen has penetrated and dried to the point where it won't be picked up by traffic, or until blotter material has been applied.

All work shall be protected and maintained at the Contractor's expense. Maintenance includes repairing areas displaced due to traffic or subsequent construction operations.

Traffic control consisting of flagpersons, pilot cars, signs, and lights shall be furnished at the Contractor's expense unless otherwise provided in the Contract.

- E. **Limitations.** A tack coat shall not be applied when the atmospheric temperature is below the temperature requirements identified in Section 408.04 M.1. The application of a prime or fog coat shall not be allowed when the atmospheric temperature is below 40°F.

After applying a prime coat to the compacted aggregate base, the prime coat shall be allowed to cure at least 48 hours after application, before placing hot bituminous pavement. The Engineer may elect to reduce this 48-hour requirement if weather conditions permit a more rapid cure. The Engineer may order blotter material to be spread at any time after application of prime coat, when it is impractical to prohibit traffic from use of the primed surface for the desired 48-hour period.

Bitumen for fog or tack coats shall not be applied on a wet surface.

401.05 METHOD OF MEASUREMENT.

- A. **Bitumen.** Bitumen will be measured by the Ton or Gallon according to Section 109.

- B. **Blotter Material.** Blotter Material will be measured by the Ton or Cubic Yard according to Section 109.

401.06 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
___ Asphalt Cement	Ton or Gallon
___ Liquid Asphalt	Ton or Gallon
___ Emulsified Asphalt	Ton or Gallon
___ Blotter Material	Ton or Cubic Yard

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

SECTION 402 COLD BITUMINOUS PAVEMENT

402.01 DESCRIPTION.

This work consists of constructing one or more courses of cold bituminous mixture on a prepared foundation.

402.02 MATERIALS.

- A. **Bitumen.** The type and grade of bitumen will be specified. Bitumen shall meet and will be accepted according to Section 818. Bitumen will be conditionally accepted at the Project and sampled according to Department's procedures in the *Field Sampling and Testing Manual*.
- B. **Aggregate.** Aggregates shall meet Section 816 for the class of aggregate specified. The aggregate will be accepted prior to the addition of bitumen. Acceptance will be based on periodic samples of the windrow after all aggregates have been blended for each lift, or taken from the stationary plant if a plant is used.

402.03 EQUIPMENT.

Equipment shall meet the following:

Item	Section
General	151.01
Self-Propelled Pneumatic-Tired Rollers	151.02 B
Smooth-Faced Steel Wheel Rollers - Tandem - Type A	151.02 C.2
Vibratory Rollers	151.02 D
Material-Hauling Equipment	151.03 B
Liquid Bitumen Distributors	151.05
Hot Bituminous Equipment	152

402.04 CONSTRUCTION REQUIREMENTS.

- A. **Pit Operations.** Stripping of the pit and pit operations shall be conducted according to Section 106.02. The Contractor shall furnish the necessary equipment and be responsible for the method of pit operations that produces an aggregate of uniform gradation and quality meeting the Specifications.
- B. **Conditioning Existing Surface.** When an existing bituminous surface was constructed under another Contract and it becomes impractical to correct local irregularities with a leveling course or the normal surfacing course, the surface shall be brought to uniform cross-section by patching with bituminous material. The mixture shall be thoroughly tamped or rolled and be the same mixture as specified for the next course. Where the existing surface is broken or shows instability, the material shall be removed, disposed, and replaced with the same mixture as specified for the next course.

To provide bond, the longitudinal or transverse joint shall be sprayed with a light coating of bitumen applied to the exposed edge before the joint is made.

The existing surface shall meet the approval of the Engineer before placing any material.

- C. **Heating of Bitumen.** The bitumen shall be heated to avoid local overheating and provide a continuous supply of bitumen to the mixer at a uniform temperature.
- D. **Hauling and Mixing Aggregates.** Hauling of materials through the paving operation or over the completed surfacing should be avoided.

If two or more materials are combined on the roadbed to make the total aggregate, each material shall be placed in a uniform windrow before combining. When two or more materials are combined at the production plant, each material shall be added with a separate mechanical feeder and conveyor or other methods which achieves the specified results.

After all aggregates have been placed on the roadbed, the entire windrow shall be manipulated until the combined materials meet the required gradation. When traveling mixers are used, pre-mixing of aggregates may be eliminated if mixing can be obtained without segregation.

E. **Mixing of Aggregates and Bitumen.**

1. **General.** Before addition of bitumen to the aggregate, the surface moisture of the aggregate shall be 3 percent or less based on the dry weight of the aggregate unless emulsified or foamed asphalt is used. If adequate mixing cannot be obtained at a moisture content of 3 percent, the moisture shall be reduced until a satisfactory mix is secured. When emulsified asphalt or foamed asphalt is used, the moisture content in the mix shall be approved by the Engineer. Mixing shall be done by either motor graders, traveling mixers, or stationary mixing plants. Mixing shall continue until the aggregate is uniformly coated.

At the end of each day, or when work is interrupted, all loose material shall be bladed and retained in a windrow until operations are resumed. During mix-

ing operations, care shall be taken to avoid cutting into the underlying course or contaminating the bituminous mixture.

If the mixture has excessive, deficient, or a non-uniform distribution of bitumen, additional aggregate or bitumen shall be added as required and the mixture remixed until a uniform mix is obtained. If excessive quantities of moisture or volatile matter exist, the mixture shall be bladed, aerated, or otherwise manipulated until it can be properly laid without shoving or rutting.

2. **Blade Mix.** This method shall be according to Section 402.04 E.1 and the following: Before adding bitumen, the aggregate shall have a uniform gradation and the windrow shall be uniform in cross section. Mixing shall be completed the same day it is started.
 3. **Traveling Mixer.** This method shall be according to Section 402.04 E.1 and the following: Before adding bitumen, the windrow shall be uniform in cross section. If the material processed and deposited by the traveling mixer is not uniformly and thoroughly mixed, further mixing shall be done.
 4. **Stationary Plant.** This method shall be according to Section 402.04 E.1.
- F. **Spreading and Finishing.** Spreading and finishing shall be performed without segregation. The material shall be shaped and compacted so the completed course conforms to the required grade and cross section within tolerances specified. Thicknesses shown on the typical section for surfacing on the Plans are a minimum. It is intended that the Plan tonnages provided in the Proposal Form be used uniformly throughout the Project.

If moisture content is excessive and compaction cannot be obtained with the normal operation, the material shall be aerated to remove excess moisture, relaid, and recompact.

If the thickness of the completed course exceeds 3 inches, the material shall be spread and compacted in two or more equal lifts as specified. After compaction, the elevation of the finished surface shall not vary by more than 0.06 foot from the prescribed elevation at any point.

The mixed material in windrows shall not exceed three miles and the mixture shall be laid while the material is in a workable condition and can be compacted to the required density.

- G. **Compaction.** The following equipment shall be the minimum furnished:
1. One Self-Propelled Pneumatic-Tired Roller meeting Section 151.02 B.
 2. One Smooth-Faced Steel-Wheel Roller: Tandem - Type A meeting Section 151.02 C.2.

All equipment used shall be operated to produce uniform compaction throughout the entire section. The method and sequence of roller operation shall be approved by the Engineer. The pneumatic tired roller shall be operated with tire pressures at 90 psi or at the maximum psi the surfacing will support as determined by the Engineer.

The desired degree of compaction will have been reached when the surface is tightly bound and shows minimal displacement under operation of the roller meeting Section 151.02 B.

The final rolling shall be done with the roller meeting Section 151.02 C.2 and shall continue until roller marks have been eliminated. Density tests may be taken to assure uniform compaction is obtained.

- H. **Completed Surface.** The surface of the course shall be smooth, uniform and true to plan crown, alignment and grade. Any low, high, or defective places shall be remedied by patching or removing and replacing the area with fresh mixture compacted to conform with the surrounding area. The patches shall be thoroughly bonded to the surface. The finished pavement shall be free from irregularities exceeding 1/4 inch as measured with a 10-foot straightedge parallel and perpendicular to the centerline of the roadway.
- I. **Maintenance of Completed Surface.** Upon completion of the final rolling and finishing, the surface shall be maintained at the Contractor's expense until the work is accepted by the Department. Maintenance shall include the repairing of areas displaced due to traffic or succeeding construction operations and shall include, if necessary, the removing, respreading, reshaping, and recompacting of such areas.
- J. **Limitations.** Bitumen shall be applied to the aggregate only when the atmospheric temperature is above 50°F. for blade mixing and above 45°F. when either traveling mixers or stationary plant mixing are used.

Materials shall not be mixed or laid when it is raining or when the roadbed or mixture is frozen. The presence of frost particles in the roadbed or in the material is sufficient evidence of being frozen.

Traffic shall be controlled by the Contractor to prevent damage to the surface during lay down and compaction.

402.05 METHOD OF MEASUREMENT.

- A. **Cold Bituminous Pavement.** Cold Bituminous Pavement will be measured by the Ton according to Section 109. Batch weights will not be permitted as a method of measurement. The Tonnage will be the weight used in the accepted pavement and no deduction will be made for the weight of bitumen in the mixture. When road mix or a traveling mixer is used, measurement will be based on the Tons of aggregate hauled plus the Tons of bitumen added to the aggregate on the roadway.
- B. **Bitumen.** Bitumen will be measured according to Section 109 and the quantity of bitumen will be the number of Tons or Gallons used in the accepted work.

402.06 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
___ Cold Bituminous Pavement	Ton
___ Liquid Asphalt	Ton or Gallon
___ Emulsified Asphalt	Ton or Gallon
___ Asphalt Cement	Ton or Gallon

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

Patching or leveling of an existing bituminous surface constructed under a previous Contract will be paid for according to the following provisions:

- A. **Excavation.** If no excavation is required, payment will be made at the Contract Unit Prices for the materials used in the repair.
- B. **Waste Material.** When the patching requires excavation, the method and site of disposal of the waste materials shall be subject to the approval of the Engineer, and:
 - 1. Payment for prime, tack, and the bitumen in the mix used in the repair will be made at the Contract Unit Prices for those items.
 - 2. If the excavated material is disposed of within the Right of Way adjacent to the work site, payment for the bituminous mixture used in the repair will be made per Ton as follows: Contract Unit Price plus the price per Ton listed in the "Price Schedule PS-1."
 - 3. If the excavated material is loaded and hauled to a disposal area not adjacent to the work site, payment for the bituminous mixture used in the repair will be made per Ton as follows: Contract Unit Price plus the price per Ton listed in the "Price Schedule PS-1."
 - 4. If aggregate is used for a portion of the backfill, or for other reasons B.2 and B.3 above are not applicable, the repair work will be paid for under Section 104.03.
- C. **Payment.** Payment as provided above will be considered full compensation for the excavation, haul, and disposal of the waste material, preparation of the area to be repaired, and for furnishing and placing the materials used in the repair.

SECTION 403 STOCKPILED HOT BITUMINOUS MIX

403.01 DESCRIPTION.

The work consists of aggregate and bituminous material mixed in a central mixing plant and stockpiled as specified in the Contract.

403.02 MATERIALS.

- A. **Bitumen.** Bitumen shall meet and will be accepted according to Section 818 and will be of the type and grade specified. Bitumen will be conditionally accepted at

the Project and sampled according to the Department's procedures in the *Field Sampling and Testing Manual*.

- B. **Aggregate.** Aggregate shall meet Section 816 for the class of aggregate or the gradation specified. The material will be tested before production can begin. After the initial sample has passed, acceptance of the aggregate will be based on gradation requirements. The gradation will be determined by the testing of one random sample taken from the hot mix plant before the addition of bitumen for each 1,000 tons of mix produced.

403.03 EQUIPMENT.

Equipment shall meet the following:

Item	Section
General	151.01
Hauling Equipment	151.03
Truck Scales	151.07
Hot Bituminous Equipment	152

403.04 CONSTRUCTION REQUIREMENTS.

- A. **Pit Operations and Stockpiling of Material.** A stockpile in one-layer dumps is not permitted. The mixed material shall be pushed up with a front-end loader and placed into a neat symmetrical pile, permitting good drainage, and having low compaction so removal of the material will not be difficult. The Contractor shall not operate any equipment on the stockpile. The approximate dimensions of the stockpile will be determined by the Engineer.
- B. **Preparation of Bituminous Material.** The bitumen shall not be overheated and shall be supplied to the mixer or drum dryer at a uniform temperature.
- C. **Preparation of Aggregate.** Ten percent of the material retained by weight on the No. 8 sieve shall have at least one fractured face. The Contractor shall not be required to split the aggregate into separate sizes or stockpiles.
- D. **Mixing.** The required quantities of aggregate and bitumen shall be introduced into the mixer and the materials mixed until a uniform and complete coating of the aggregate is obtained.

The asphalt content of the bituminous mixture shall not vary from the quantity determined by the Engineer by more than ± 0.50 percentage points. The use of the flow rate meter as specified in Section 152.01 F is not required.

The aggregate shall be dried and heated at the plant to reduce the moisture in the bituminous mixture to no more than that percentage specified. A moisture sample will be taken for each 1,000 tons of mix produced. The maximum mix temperature at mixer discharge shall be 225°F.

403.05 METHOD OF MEASUREMENT.

- A. **Stockpiled Hot Bituminous Mix.** Stockpiled Hot Bituminous Mix will be measured by the Ton according to Section 109. Batch weights will not be used for

measurement unless the plant is equipped with an automatic batching and weighing system conforming to Section 151.07. The tonnage will be the weight of the accepted material placed in the stockpile. No deduction will be made for the weight of bitumen used in the mixture.

- B. **Bitumen.** Bitumen will be measured according to Section 109 and the quantity of bitumen will be the number of Tons used in the accepted work.

403.06 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Stockpiled Hot Bituminous Mix	Ton
Liquid Asphalt	Ton

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

SECTION 405 REMOVE AND SALVAGE BITUMINOUS PAVEMENT

405.01 DESCRIPTION.

This work consists of partially or completely removing a bituminous surface, and loading, hauling, and stockpiling the material.

405.02 CONSTRUCTION REQUIREMENTS.

- A. **Prepare Stockpile Site.** The Contractor shall remove and stockpile all available topsoil, up to a maximum of 1 foot. The site shall be shaped and compacted so water drains away from the salvaged bituminous stockpile. The Contractor shall furnish, place, compact, and shape to drain, a 6-inch depth of granular material, with less than 30 percent passing the No. 200 sieve over the stockpile site.
- B. **Stockpiling.** The salvaged material shall be stockpiled according to Section 106.06. Each stockpile shall be located to facilitate future processing and access to the material without interference of other stockpiles.
- C. **Restore Stockpile Site.** The Contractor shall restore the stockpile site upon completion of the Project. The unused or waste bituminous material and aggregate bedding shall be disposed of at locations acceptable to the Engineer. The stockpile site shall be lightly scarified and shaped to drain. The topsoil shall be spread uniformly over the site. The site shall be seeded and fertilized with the class of seed specified.

- D. **Remove and Salvage Bituminous Surfacing.** Salvaged bituminous surfacing shall be removed, without contamination, to the specified depth, width, location, and surface tolerance designated. Before removal, the surface shall be cleaned of all debris. Tracked or wheeled loaders may be used for removal. The use of earthmoving equipment such as dozers or scrapers will not be permitted unless the Contractor can satisfactorily demonstrate to the Engineer that no contamination from underlying material will occur.

During the removal operations the Contractor shall control the dust and prevent any littering on the traffic lanes.

If the Project is open to traffic, the edge of the area where the surfacing has been removed shall be tapered up to meet the surface of the adjacent remaining pavement. This shall be done at each end of the removal operation, and at intersecting roadways, at the end of the day.

At the end of the work day all equipment, materials, residue from salvage operations, or other items that may be a hazard to traffic shall be removed from the roadway according to Section 107.05.

405.03 METHOD OF MEASUREMENT.

- A. **Prepare Stockpile Site.** Prepare Stockpile Site will be measured as a completed and accepted unit item to be bid as a "Lump Sum." The Lump Sum shall be considered payment for removing and stockpiling topsoil; shaping and compacting subgrade; furnishing, placing, shaping, and compacting granular material; all labor, equipment, and materials required for the stockpile site(s).
- B. **Restore Stockpile Site.** Restore Stockpile Site will be measured as a completed and accepted unit item to be bid as a "Lump Sum." The Lump Sum payment will be considered full payment for all disposal or wastes, spreading topsoil, compaction, blading, water, seed, fertilizer, labor, equipment, and materials required to complete the item.
- C. **Remove and Salvage Bituminous Surfacing.** Remove and Salvage Bituminous Surfacing will be measured by one of the following:
1. Ton, weighed to the nearest 0.10 Ton of material in the hauling unit.
 2. Cubic Yard, measured to the nearest 1/4 Cubic Yard of material in the hauling unit.
 3. Square Yard, measured to the nearest Square Yard of bituminous surfacing in place prior to milling or removing.

The work of cleaning the surface; removing, loading, hauling (if not a specified Pay Item); stockpiling the removed material; brooming; cleaning/brooming water; water used in milling; and all labor, equipment, materials, and incidentals required to complete the Bid Item, will not be measured for payment and shall be included in the bid item "Remove and Salvage Bituminous Surfacing."

- D. **Hauling.** Hauling, if specified as a Pay Item, will be measured by either the Ton-Mile, or the Cubic Yard-Mile.

405.04 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Prepare Stockpile Site	Lump Sum
Restore Stockpile Site	Lump Sum
Remove and Salvage Bituminous Surfacing	Ton, Cubic Yard, Square Yard
Hauling	Ton-Mile, Cubic Yard-Mile

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

SECTION 407 HOT RECYCLED BITUMINOUS PAVEMENT

407.01 DESCRIPTION.

This work consists of processing and placing salvaged bituminous material on the roadway. Processing may include crushing, screening, blending, adding bitumen, virgin aggregate, or other specified additives.

407.02 MATERIALS.

- A. **Bitumen.** The type and grade of bitumen will be specified and shall meet and will be accepted according to Section 818. Bitumen will be accepted as outlined in the Combined State Binder Group agreement for North Dakota. Samples will be obtained by the Contractor under the observation of the Engineer, and immediately handed over to the Engineer for shipping and testing.
- B. **Salvaged Bituminous Material.** The salvaged material shall be processed to the maximum size and gradation specified.
- C. **Virgin Aggregate.** The virgin aggregate shall be specified on the Plans. Aggregate will be sampled before the addition of bitumen. Acceptance will be based on periodic samples taken from the hot mix plant.
- D. **Recycling Agent.** Recycling Agent shall meet Section 818.

407.03 EQUIPMENT.

- A. **General.** Equipment shall meet the following:

Item	Section
General	151.01

Self-Propelled Pneumatic-Tired Rollers	151.02 B
Smooth-Faced Steel Wheel Rollers - Tandem - Type A	151.02 C.2
Smooth-Faced Steel wheel Rollers - Tandem - Type B	151.02 C.3
Vibratory Rollers	151.02 D
Combination Roller	151.02 E
Material-Hauling Equipment	151.03 B
Bituminous Pavers	151.04
Scales	151.07
Hot Bituminous Equipment	152

- B. **Recycling Plant.** The mixing plant shall be a drum-dryer, continuous mix, or batch plant, equipped to independently control and proportion the virgin aggregate, salvaged bituminous material, bitumen, and recycling agents at the specified rates and proportions. The plant shall be equipped to independently and continuously display the proportions or quantities of all materials being introduced into the mixer.

The mixing plant shall produce a hot recycled bituminous mixture without adversely affecting the quality of the processed salvaged bituminous material. The salvaged bituminous material shall be protected from direct contact with the heating flames by shielding or by introduction into the heat chamber without flame contact. The mixing plant pollution control equipment shall reduce pollution emissions below the maximums established by the North Dakota State Health Department.

407.04 CONSTRUCTION REQUIREMENTS.

The Contractor shall have at least one person in charge of quality control on the project at all times. This person shall be qualified as an Asphalt Mix Controller as outlined in the Department's Technician Certification Program.

- A. **Processing Salvaged Material.** Salvaged bituminous material shall be processed with minimal waste to the maximum size specified before introduction into the recycling plant.
- B. **Pit Operations and Stockpiling of Aggregate.** Stripping of the pit and pit operations shall be conducted according to Section 106.02.
- Sufficient virgin aggregate shall be stockpiled at the plant site to produce 10,000 tons of recycled bituminous mixture, or 50 percent of the estimated required quantity, whichever is less, before starting recycled bituminous mix production.
- C. **Prepare Stockpile Sites.** The Contractor shall remove and stockpile all available topsoil, up to a maximum of 1 foot. The site shall be shaped and compacted so water drains away from the salvaged bituminous stockpile. The Contractor shall furnish, place, compact, and shape to drain, a 6-inch depth of granular materials, with less than 30 percent passing the No. 200 sieve over the stockpile site.
- D. **Stockpiling.** The salvaged material shall be stockpiled according to Section 106.06. Each stockpile shall be located to facilitate future processing and access to the material without interference of other stockpiles.
- E. **Restore Stockpile Site.** The Contractor shall restore the stockpile site upon completion of the Project. The unused or waste bituminous material and aggregate

bedding shall be disposed of at locations acceptable to the Engineer. The stockpile site shall be lightly scarified and shaped to drain. The topsoil shall be spread uniformly over the site. The site shall be seeded and fertilized with the class of seed specified.

- F. **Mix Design.** The mix design used shall be a lab mix design determined according to the Department's Mix Design Procedure. The Contractor shall provide the Engineer with a representative sample and the blend proportions of the aggregate to be incorporated into the mix. The total weight of the combined sample shall be approximately 75 pounds. This sample shall meet the specified gradation and the other requirements of Section 816.

The Contractor shall also provide a 2-gallon sample of bitumen, in 1-quart containers, of the type and grade specified in the Plans. The bitumen shall meet all requirements of Section 818 and shall be from the supplier the Contractor uses for the project.

The Contractor shall submit the aggregate blend proportions and the type, grade, and name of the supplier of the bitumen in writing with the submission of the samples. The aggregate and bitumen samples shall be submitted seven working days before the start of the paving operations.

If aggregate or asphalt is utilized from sources other than those initially submitted or if a different type or grade of asphalt is used, the Contractor shall provide a sample to the Engineer five days before incorporating the material into the work. If the Contractor fails to provide a timely sample, the Contractor shall cease operations and allow the Department five working days to prepare a new mix design.

- G. **Heating of Bitumen.** The bitumen shall not be overheated and shall be continuously supplied to the mixer at a uniform temperature.
- H. **Preparation of Virgin Aggregate.** For batch or continuous mix plants, aggregates shall be heated and dried to reduce the total moisture content to one-half of 1 percent or less based on the dry weight of the aggregate.

When the drum-dryer mixer is used, the moisture content of the bituminous mixture shall not exceed 1 percent.

If the quantity of virgin aggregate exceeds 50 percent of the total recycled mixture, the aggregates prepared for use with a cold feed control shall be screened into two or more fractions consisting of at least a fine and course aggregate stockpile. The aggregate shall be fed from the stockpile into separate compartments for accurate proportioning into the mixer. If the quantity of virgin material is less than or equal to 50 percent of the total recycled mixture, splitting the aggregate into separate fine and course stockpiles is not required.

- I. **Mixing.** Virgin aggregate shall be combined with the salvaged bituminous material, bitumen, and recycling agent so the materials are blended into the proportions established by the mix design. The material shall be mixed until a uniform and complete coating of the aggregate is obtained. The recycled hot bituminous material shall not contain clumps of salvaged material when delivered to the road for placing.

Bitumen shall be proportioned within ± 0.24 percentage points of the percentage of bitumen designated by the Engineer. Acceptance will be according to Section 407.05 A.

- J. **Mix Temperature.** The recycled hot bituminous material shall be produced at a mixing temperature which provides a uniformly heated mixture delivered at the point of laydown at a minimum of 230 F. when the ambient temperature is above 60°F. and 250°F. when the ambient temperature is below 60°F. The temperature of the mix when discharged from the mixer shall not exceed 300 F.
- K. **Conditioning Existing Surface.** When it becomes impractical to correct local irregularities on an existing surface with a single lift leveling course or the pavement course and milling was not specified, the surface shall be brought to uniform cross section with additional bituminous mix. The mixture shall be thoroughly tamped or rolled with the same mixture specified for the next course. Where the existing surface is broken or unstable, the material shall be removed, disposed of, and replaced, as directed by the Engineer, with the same mixture specified for the next course.

Spot leveling courses shall be blade laid in lifts not to exceed 3 inches in depth.

Patching operations include removal of existing surfacing, base, and subgrade material to the depth required to obtain a stable subgrade. If required, a class of aggregate satisfactory to the Engineer shall be placed and compacted to the bottom of existing bituminous pavement to a minimum depth of 3 inches below the existing surface. The hot bituminous material shall be placed with a motor grader in lifts not to exceed 3 inches, compacted with rubber-tired equipment and cured for 48 hours before being overlaid, except in such instances where the breakup occurs during the actual paving operation. If the breakup occurs during the paving operation, a 48-hour curing period will not be required.

After removing loose dirt and other objectionable material from the surface, a tack coat shall be applied to the surface and to the exposed edges of longitudinal and transverse joints before placing a leveling or surface course.

- L. **Spreading and Finishing.** All mixtures shall be spread and finished with bituminous pavers to the required section leaving the mixture uniformly dense, smooth, and free from irregularities. In locations where it is impractical to use normal laydown equipment, other methods may be used when approved by the Engineer.

Loads of mix and sections of pavement containing uncoated batches of aggregate, segregated materials, aggregate which is obviously outside gradation Specifications, or too much bitumen will be rejected. Loads showing these characteristics shall not be used in the work. If these conditions are evident after finishing operations, the defective sections will be rejected, removed, and replaced at the Contractor's expense. If the quality of the mix on the road is in question, the Engineer may test samples taken from the in-place work before final acceptance.

The speed of the bituminous paver shall be controlled to lay the mixture uniformly, and continuously without tearing or gouging. The paver's speed shall not exceed the manufacturer's recommendation and shall be coordinated with the output of the plant to provide for a smooth continuous operation with the paver.

All transverse and longitudinal joints, high or low areas, and surface irregularities shall be leveled, filled, or raked before compaction. Loose material shall be removed from previously compacted lanes or joints before compacting adjacent lanes.

Paving operations shall be conducted to minimize the inconvenience to traffic and protect existing and finished surfaces. Placing bituminous mixture shall progress so a single lane is not more than one day's run in advance of any adjacent lane. Altering the sequence of paving operations to best suit construction conditions may be required. The Contractor shall not permit two-way traffic past the machine laydown operation and two-way traffic without the use of a Contractor-furnished pilot car.

Hot bituminous pavement shall not be placed on bridge decks unless specified.

When required, the Contractor shall excavate locations where the new surfacing meets existing pavement, bridge ends, or railroad crossings to allow full depth placement of the surfacing course. If excavation is required, it will be performed according to Section 104.03.

M. **Compaction.**

1. **General.** Except for shoulders, driveways, section line approaches, leveling courses and patching, the bituminous mixture shall be compacted according to Section 407.04 M.3, Specified Density.

The sequence of rolling operations and the selection of type and number of rollers shall be commensurate with production and shall be adequate to attain the specified density before the mat temperatures falls below 175°F.

Rolling shall begin at the edge and proceed parallel to the road centerline with each trip overlapping the previous roller pass, and progressing to the crown of the road. When paving in echelon or abutting a previously placed lane, the longitudinal joint should be rolled first followed by the regular rolling procedure. On super-elevated curves, the rolling shall begin at the low side and progress to the high side by overlapping of longitudinal trips parallel to the centerline. Displacement resulting from reversing the direction of a roller, or from other causes, shall be corrected immediately with rakes and the addition of fresh mix. Care shall be exercised in rolling edges of the bituminous mixture so line and grade of the edge is maintained.

In areas not accessible to rollers such as along forms, curbs, headers and walls, the mixture shall be thoroughly compacted with hand or mechanical tampers.

Any mixture that becomes loose and broken, mixed with dirt, or shows any excess or deficiency of bitumen or is defective in any manner shall be removed and replaced with fresh hot mixture, and compacted to the density of the surrounding area.

2. **Ordinary Compaction.** Ordinary Compaction shall be used on leveling courses and patching.

Compaction consists of initial or breakdown rolling, intermediate rolling, and final or finish rolling.

Breakdown rolling consists of 1 or more complete coverages with a roller meeting Sections 151.02 B, 151.02 C.2, or 151.02 D.

Breakdown rolling shall be followed by intermediate rolling with a roller conforming to Section 151.02 B until the surface is tightly bound and shows no displacement under the roller. Intermediate rolling shall be completed before the mat temperature falls below 185°F.

The final rolling shall be performed with a roller conforming to Section 151.02 C.3 or 151.02 D in the static mode, and shall continue until roller marks are eliminated.

The Contractor may be required to modify the rolling sequence to best suit construction conditions.

When compacting leveling courses and patches spread with motor graders, the initial rolling shall be by pneumatic-tired rollers done simultaneously with the spreading. Additional pneumatic-tired rollers required for obtaining compaction shall conform to Section 151.02 B. The roller specified for final rolling may be omitted with approval of the Engineer. The desired degree of compaction will be considered obtained when the surface is tightly bound and shows no displacement under operation of the roller.

3. **Specified Density.** This method provides for compacting bituminous mixture on interstate crossroads, ramps, rest area approaches, parking lots, and mainline pavement according to the density requirements specified in Section 408.05 C.

Bituminous mixture placed on shoulders, driveways, and section line approaches are exempt from the specified density requirements. Such mixtures shall be compacted to the satisfaction of the Engineer with the same rollers and rolling sequences used on the mainline. In confined areas, other rollers may be used, as approved by the Engineer.

- N. **Joints.** Joints shall be tacked and constructed with adequate bond on abutting surfaces. Vertical construction joints in successive courses shall be placed so the joints do not fall in the same vertical plane.

Pavement placed against the surface of curbing, gutters, manholes, and similar structures shall be placed uniformly high near the contact surfaces so the pavement will be slightly higher than the edge of the structure after compaction.

- O. **Maintaining Completed Course.** Upon completion of the final rolling and finishing, surface maintenance required due to construction operations shall be at the Contractor's expense until the next or final surface is placed or until the work has been accepted by the Department. Maintenance shall include the removing, replacing, reshaping, and recompacting of damaged areas.
- P. **Tolerances.** The surface shall be smooth, uniform, and true to Plan crown, alignment, and grade. Surfacing thicknesses shown on the typical sections are minimum and the estimated plan tonnages shall be used uniformly throughout the Project. Any low or high defective areas shall be corrected as directed by the Engineer. Corrective work shall include patching or cutting out the surface and replacing with fresh hot bituminous mixture or by milling the surface. The surface of the finished pavement shall be free from irregularities exceeding 3/16 inch as measured with a 16-foot straightedge parallel and perpendicular to the centerline of the roadway.

Deficiencies in smoothness, improperly constructed joints, and surface irregularities shall be corrected with a second diagonal rolling crossing the line of the first at the Contractor's expense.

Q. Limitations.

- Weather.** Hot recycled bituminous mix shall not be placed on a damp surface, on a frozen roadbed, or when weather conditions prevent the proper handling or finishing of the bituminous mixtures. Presence of frost particles in the roadbed is sufficient evidence of being frozen. Hot recycled bituminous mix shall not be placed when the air or mat surface temperatures are below the following minimums:

AIR TEMPERATURE			
Compacted Thickness	Surface Course	Subsurface Course and Approaches	Existing Mat Temperature*
1-1/2" or less	45°F.	40°F.	40°F.
More than 1-1/2"	40°F.	35°F.	40°F.

*Existing mat temperature will be measured with an infrared sensing thermometer or by a conventional thermometer inserted into a 1-inch deep hole in the pavement and filled with water, oil, or grease.

- Operational.** Traffic shall not be permitted on the completed surfacing until the lift has been compacted and has cooled sufficiently to prevent damage.
- R. Bituminous Pavement Sloughs.** Bituminous pavement sloughs shall be compacted with rollers capable of providing a smooth finished compacted slough that is free of tire marks and unevenness or drop-off. Density tests are not required.

407.05 ACCEPTANCE.

- A. Bitumen Content.** The required bitumen content, or target percentage, will be designated by the Engineer. The quantity of bitumen used and paid for from each lot will be determined by the use of daily oil cutoffs following the procedures outlined on the Mix Bitumen Cutoff Report. A lot shall be defined as the amount of bitumen used each production day.

The pay factor for the hot bituminous pavement, adjusted for bitumen content, will be the lowest pay factor determined by both of the following methods:

- Average.** If the daily cutoff, as determined on the Mix Bitumen Cutoff Report, deviates from the target percentage set by the Engineer by more than 0.24 percentage points the pay factor will be determined from the following table:

BITUMEN CONTENT

Pay Factor	Deviation from Target in Percentage Points
1.00	0.00-0.24
0.98	0.25-0.29
0.95	0.30-0.34
0.92	0.35-0.39
*	0.40 & Over

*The Engineer will determine the pay factor according to Section 105.07.

2. **Uniformity.** The Engineer will make four random checks of the asphalt content each day based on readings from the totalizers for the aggregate and the bitumen as outlined in the Asphalt Content Determination Report. When less than four checks are made because of inclement weather, equipment breakdown, or other causes, the daily average will be based on the lesser number of checks. If the asphalt content from any random reading varies from the daily average of the readings by more than 0.24 percentage points, the pay factor for the hot bituminous material will be adjusted according to the following formula:

$$\text{Pay Factor} = \frac{100 - [20 (* \text{Deviation} - 0.24)]}{100}$$

*Deviation from the average daily asphalt content.

- B. **Compaction.** Compaction of mainline pavement will be tested, cored, and accepted according to Section 408.05 C.
- C. **Aggregate.** One virgin aggregate sample will be taken for every 500 tons of virgin aggregate used, with a maximum of three tests per day. The Contractor shall obtain all aggregate samples, under the observation of the Engineer, at random times determined by the Engineer. The samples shall be taken from the cold feed belt according to AASHTO T 2, Section 4.3.1 or 4.3.2.

If material is produced that deviates from the specified gradation for three consecutive tests, incorporation of additional material into the work will not be allowed until the Contractor takes the necessary corrective action to meet the Specifications. Acceptance or rejection of the failing material will be according to Section 105.07.

407.06 METHOD OF MEASUREMENT.

The estimated quantities provided may be adjusted by the Engineer in the field. Any increase or decrease in the quantities used shall not be a basis for renegotiation in the price bid for these items.

- A. **Recycled Hot Bituminous Pavement.** Recycled Hot Bituminous Pavement, including virgin aggregate, salvaged bituminous material, bitumen, and recycling agents will be measured by the Ton. No deduction will be made for the weight of bitumen, recycling agent, virgin aggregate, or other additives in the mix. Processing the salvaged bituminous material to meet the maximum size will be included in the Bid Item.

- B. **Bitumen.** The bitumen will be measured by the Ton of bitumen actually used in the work.
- C. **Virgin Aggregate.** Virgin aggregate will be measured by the Ton of this material actually used in the work. The final quantity of virgin aggregate will be determined by the following formula:

$$VA = \%VA \{RP - (AC + \text{Additives})\}$$

where:

VA = quantity of virgin aggregate used this lot

$$*\%VA = \frac{\text{weight virgin aggregate}}{\text{weight virgin aggregate} + \text{weight salvaged material}}$$

RP = weight of the recycled hot bituminous pavement produced this lot

AC = weight of asphalt used this lot

Additives = weight of all additives this lot.

*The weight of the virgin aggregate and the salvaged material will be free of moisture and will be taken from the scale totalizers in the plant. The percentage of virgin aggregate used will be the average percentage of virgin aggregate (%VA) incorporated into the mix for each lot. The average %VA will be based on readings from 4 random checks of the totalizer weights for the aggregate and salvaged materials.

- D. **Recycling Agent.** The recycling agent will be measured by the Ton of material actually used in the work.
- E. **Prepare Stockpile Site.** Prepare Stockpile Site will be measured as a completed and accepted unit item to be bid as a Lump Sum. This Lump Sum shall be considered payment for removing and stockpiling topsoil; shaping and compacting sub-grade; furnishing, placing, shaping, and compacting granular material; all labor, equipment, and materials required for the stockpile site(s).
- F. **Restore Stockpile Site.** Restore stockpile site will be measured as a completed and accepted unit item to be bid as a Lump Sum. The Lump Sum payment will be considered full payment for all disposal of wastes, spreading topsoil, compaction, blading, water, seed, fertilizer, labor, equipment, and materials required to complete the item.
- G. **Cored Sample.** Each individual cored sample that is removed, sawed, and delivered to the Department in the required condition will be measured as a unit. The work vehicle with its attachments, the coring machine, the masonry saw, and the shadow vehicle with its attachments, will not be measured for payment, but will be included in the measurement of the cored sample.

407.07 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Recycled Hot Bituminous Pavement	Ton

___Asphalt Cement	Ton
Virgin Aggregate, Cl. ___	Ton
Recycling Agent	Ton
Prepare Stockpile Site	Lump Sum
Restore Stockpile Site	Lump Sum
Cored Sample	Each

This payment shall be full compensation for all labor, equipment, and materials necessary to complete the work.

When price adjustments are required for failing material or patching, payment will be made as follows:

- A. Determination of the payment adjustment of a lot of bituminous mixture will be made by successively multiplying the Contract Unit Price per Ton of the bid item by the applicable pay factors as determined in Sections 408.05 A and 408.05 B.
- B. Material for patching or leveling of an existing bituminous surface constructed under a previous Contract shall be obtained from the tonnage provided in the basis of estimate and will be paid according to the following provisions:
 1. If no excavation is required, payment will be made at the Contract Unit Prices for the materials used in the repair.
 2. When the patching requires excavation, the method and site of disposal of the waste materials shall be subject to the approval of the Engineer, and:
 - a. If the excavated material is disposed of within the Right of Way adjacent to the work site, payment for the bituminous mixture used in the repair will be made per Ton as follows: Contract Unit Price plus the price per Ton listed in the "Price Schedule PS-1."
 - b. If the excavated material is loaded and hauled to a disposal area not adjacent to the work site, payment for the bituminous mixture used in the repair will be made per Ton as follows: Contract Unit Price plus the price per Ton listed in the "Price Schedule PS-1."
 - c. If aggregate is required to replace excavated material in the existing base or subgrade, payment for the class of aggregate used will be made under Section 104.03. Payment will include disposal of excavated material, and the furnishing, placing, and compacting of the aggregate.
 - d. Payment for prime, tack, and the bitumen in the mix used in the repair will be made at the Contract Unit Prices for those items.

SECTION 408 HOT BITUMINOUS PAVEMENT

408.01 DESCRIPTION.

This work consists of constructing one or more courses of bituminous pavement on a prepared foundation.

The bituminous pavement will be a mixture of aggregate, filler if required, and bitumen.

The Contractor shall be responsible for providing an aggregate that meets the mix design properties specified.

408.02 MATERIALS.

- A. **Bitumen.** The bitumen shall meet Section 818 and will be of the type and grade specified in the Contract. Bitumen will be accepted as outlined in the Combined State Binder Group agreement for North Dakota. Samples will be obtained by the Contractor under the observation of the Engineer, and immediately handed over to the Engineer for shipping and testing.
- B. **Aggregate.** Aggregate shall meet Section 816 for the class of aggregate specified. Acceptance will be according to Section 408.05 A.

408.03 EQUIPMENT.

Equipment shall meet the following:

Item	Section
General	151.01
Self-Propelled Pneumatic-Tired Rollers	151.02 B
Smooth-Faced Steel Wheel Rollers - Tandem - Type A	151.02 C.2
Smooth-Faced Steel Wheel Rollers - Tandem - Type B	151.02 C.3
Vibratory Rollers	151.02 D
Combination Roller	151.02 E
Material-Hauling Equipment	151.03 B
Bituminous Pavers	151.04
Scales	151.07
Hot Bituminous Equipment	152

408.04 CONSTRUCTION REQUIREMENTS.

The Contractor shall have at least one person in charge of quality control on the project at all times. This person shall be certified as an Asphalt Mix Controller, as outlined in the NDDOT Transportation Certification Program. If the Prime Contractor sublets any portion of the Contract, including aggregate production, to a Subcontractor, the Subcontractor shall also have a person certified as an Asphalt Mix Controller on the Project. If the Subcontractor does not have a certified person, the Prime Contractor's certified person shall be on the Project and be in charge of quality control.

A. Pit Operations and Stockpiling of Aggregate.

The processed stockpiles shall be uniform and shall meet gradation requirements. Sufficient mineral aggregate shall be stockpiled at the plant site to produce at least 25,000 tons of bituminous mixture or 50 percent of the estimated required quantity, whichever is less, before the start of bituminous mix production. During bituminous mix production, the aggregate stockpiles shall be maintained so they contain sufficient material to produce at least 5,000 tons of bituminous mixture or 25 percent of the estimated required quantity to finish production at the particular plant setup, whichever is less.

During the first week of aggregate production, for each class of aggregate, as soon as the Contractor determines the aggregate is representative, and prior to the initial mix design, the Contractor shall obtain a 90-pound sample of each aggregate component. The Contractor shall split the samples under the observation of the Engineer. One-half of each aggregate sample will be submitted to the Engineer for testing. The Contractor and the Engineer will test the samples to determine the bulk (dry) and apparent specific gravity and the percent water absorption by dry weight of aggregate. The testing will be completed according to AASHTO T 84, T 85, and the Department's procedures in the *Field Sampling and Testing Manual*. One test will be performed for each 10,000-ton of each aggregate component produced. A minimum of two tests will be required for each aggregate component. Testing shall commence within two working days of sampling. Test results will be reported to each party as soon as they are available.

If the individual specific gravity values determined by the Contractor and the Department correlate within 0.040, the average of the Contractor's numbers will be used to calculate the absorption, fines to asphalt ratio, and voids in mineral aggregate (VMA). If the individual specific gravity values determined by the Contractor and the Department do not correlate within the allowable tolerance (0.040), or if the Contractor fails to supply an aggregate that meets the mix design criteria, then:

1. The mix design will not be approved and mix production will not begin.
2. The Contractor has the option of running the test together with Department personnel at the District Lab and use those results, or testing differences can be resolved according to the Department's procedures in the *Field and Testing Manual*.

- B. **Mix Design.** During production of the aggregate, the Contractor will perform gradation testing using the Department's procedures in the *Field Sampling and Testing Manual*. The testing frequency will be a minimum of one test per 1,000 tons of aggregate produced for the first 10,000 tons of aggregate. After 10,000 tons of aggregate is produced the testing frequency will be a minimum of one test per 2,000 tons of aggregate.

The Contractor will provide the Engineer with an aggregate sample representing each stockpile. The total weight of the combined sample will be about 150 pounds. This sample will be used, by the Department, to develop a mix design when the Plans do not specify a Contractor Mix Design. When the Plans specify a Contractor Mix Design, the Contractor is still required to submit this sample. A sample tag identifying the project number, pit location, and class of aggregate shall be attached to the sample. The Contractor shall also submit in writing the average gradation of each stockpile and the proposed percentage of each stockpile to be used. Regardless of who is preparing the mix design, the Contractor shall provide the Department with the bitumen, aggregate and blend portions for the mix design, a minimum of seven days before production begins.

The Contractor shall provide eight 1-quart containers of bitumen of the type and grade specified in the Plans with the aggregate samples submitted. The type, grade, and name of the supplier of the bitumen shall be submitted, in writing, with the sample. The bitumen shall meet all requirements of Section 818 and shall be from the supplier the Contractor uses for the project.

An approved mix design will be required prior to beginning plant production on all projects of hot bituminous pavement. The Department will develop the mix design unless the plans specify a contractor mix design. The mix design will be developed according to the Department's *Field Sampling and Testing Manual*. The mix design will meet the following properties for the type of mix specified:

Mix Criteria	CLASS 27				CLASS 29				CLASS 31				CLASS 33			
	Top or wearing course		Bottom or non-wearing course		Top or wearing course		Bottom or non-wearing course		Top or wearing course		Bottom or non-wearing course		Top or wearing course		Bottom or non-wearing course	
	Min	Max	Min	Max												
Blows to Marshall Plug	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Stability (lbs.)	1200		1200		1500		1500		1650		1650		1800		1800	
Flow, 0.01 in.	8	18	8	18	8	18	8	18	8	16	8	16	8	16	8	16
Percent VMA ^{1,3}	14.0	16.0	14.0	16.0	14.0	16.0	14.0	16.0	14.0	16.0	14.0	16.0	14.0	16.0	14.0	16.0
Fines/Asphalt Ratio ^{2,3}	0.6	1.3	0.6	1.4	0.6	1.3	0.6	1.4	0.6	1.3	0.6	1.4	0.6	1.3	0.6	1.4
Film Thickness ³	7.5		7.5		7.5		7.5		7.5		7.5		7.5		7.5	

¹ Voids in Mineral Aggregate (VMA).

² The fines/asphalt ratio shall be determined by dividing the percentage of material passing the #200 sieve by the percentage of effective asphalt added to the mix. The percentage of asphalt used will be as determined in the Mix Design at 4 percent air voids. The effective asphalt will be determined as follows: (The formula is as defined in Manual Series No. 2 published by the Asphalt Institute.)

$$AC_{\text{effec}} (\text{Mix Basis}) = \%AC - \left\{ \frac{\% \text{Absorbed AC by weight of aggregate} \times \% \text{Aggregate in mix}}{100} \right\}$$

Perform calculations to the nearest hundredth and round to the nearest tenth.

³ The mix design will be approved if the laboratory mix meets one of the three properties, percent VMA, Fines/Asphalt Ratio, Film Thickness, and all of the other specified properties.

The target value for each sieve for the mix design shall be the average of production samples multiplied by the percentage of material used in the blend proportion. The Department will blend the aggregate at the blend proportions specified by the Contractor. The blended sample will be used for the mix design if the gradations obtained from the blended sample are within the tolerances listed in Table A when compared to the target values determined previously. If the aggregate is not within tolerance a mix design will not be developed. Mix production will not begin until a mix design is developed.

TABLE A
ACCEPTABLE TOLERANCES

5/8" - #4 sieve	± 5%
#30 sieve	± 3%
#200 sieve	± 1.5%
Plastic Index	± 2%

The result of the mix design process is the Job Mix Formula (JMF), and will contain the following:

1. The percentage of aggregate passing each of the specified sieves.
2. The percent asphalt cement to be added to the mixture.
3. The target air voids will be 4 percent.
4. The maximum specific gravity of the mixture obtained in the laboratory.
5. The bulk specific gravity of the mixture obtained in the laboratory.
6. The percent VMA of the mixture obtained in the laboratory.
7. The stability of the mix (Marshall only).
8. The fines/asphalt ratio.
9. The asphalt film thickness.

The target value for each sieve may be adjusted during production if the Engineer and the Contractor agree that a change is necessary to maintain the air voids between 3 and 5 percent. Any change to the JMF will be checked immediately using the procedures required in Section 408.05 C.

If aggregate or asphalt is utilized from sources other than those initially submitted, if the aggregate is processed using a different crusher, or if a different type or grade of asphalt is used, the Contractor shall notify the Engineer in writing five days before incorporating the material into the work. If the Engineer determines that a new mix design is required, the Contractor shall provide a sample of the material to the Engineer and allow the Department three working days to prepare or approve a new mix design. If the Contractor fails to provide a timely sample, the Contractor shall cease operations and allow the Department three working days to prepare or approve a new mix design.

- C. **Heating of Bitumen.** The bitumen shall not be overheated and shall be continuously supplied to the mixer or drum dryer at a uniform temperature.
- D. **Preparation of Aggregate.** For batch or continuous mix plants, the aggregates shall be heated and dried to reduce the total moisture content to one-half of 1 percent or less based on the dry weight of the aggregate.

When the drum-dryer mixer is used, the moisture content of the bituminous mixture shall not exceed 1 percent.

Aggregates prepared for use with a cold-feed control shall be screened into two or more fractions consisting of at least a fine and course aggregate stockpile. The aggregate shall be fed from the stockpile into separate compartments for accurate proportioning into the mixer.

- E. **Mixing.** All materials shall be introduced uniformly into the pug mill or the drum dryer, in the proportions necessary to produce the required quality. Bitumen shall be proportioned within ± 0.24 percentage points of the percentage of bitumen designated by the Engineer.

The required quantities of aggregate and bitumen shall be introduced into the mixer and the materials mixed until a uniform and complete coating of the aggregate is obtained.

- F. **Mix Temperature.** The temperature of the bituminous mixture at discharge from the mixer shall not exceed 300°F. The temperature of the mix at laydown shall be a minimum of 230°F. when the ambient temperature is above 60°F., and 250°F. when the ambient temperature is below 60°F.

If the density and temperature requirements of Section 408.04.I are not being met, the actual mixing temperature shall be adjusted so the specified requirements are satisfied.

- G. **Conditioning Existing Surface.** When it becomes impractical to correct local irregularities on an existing surface with a single lift leveling course or the pavement course and milling was not specified, the surface shall be brought to uniform cross section with additional bituminous mix. The mixture shall be thoroughly tamped or rolled and shall be the same mixture as specified for the next course. Where the existing surface is broken or unstable, the material shall be removed, disposed of, and replaced with the same mixture specified for the next course.

Spot leveling courses shall be blade laid in lifts not to exceed 3 inches in depth.

Patching operations include removal of existing surfacing, base, and subgrade material to the depth required to obtain a stable subgrade. If required, a class of aggregate satisfactory to the Engineer shall be placed and compacted to the bottom of existing bituminous pavement to a minimum depth of 3 inches below the existing surface. The hot bituminous material shall be placed with a motor grader in lifts not to exceed 3 inches, compacted with rubber-tired equipment and cured for 48 hours before being overlaid, except in such instances where the breakup occurs during the actual paving operation. If the breakup occurs during the paving operation, a 48-hour curing period will not be required.

After removing loose dirt and other objectionable material from the surface, a tack coat shall be applied to the surface and to the exposed edges of longitudinal and transverse joints before placing a leveling or surface course.

- H. **Spreading and Finishing.** All mixtures shall be spread and finished with bituminous pavers to the required section leaving the mixture uniformly dense, smooth, and free from irregularities. In locations where it is impractical to use normal lay-down equipment, other methods may be used when approved by the Engineer.

Loads of mix and sections of pavement containing uncoated batches of aggregate, segregated materials, aggregate which is obviously outside gradation Specifica-

tions, or too much bitumen will be rejected. Loads showing these characteristics shall not be used in the work. If these conditions are evident after finishing operations, the defective sections will be rejected, removed, and replaced at the Contractor's expense. If the quality of the mix on the road is in question, the Engineer may test samples taken from the in-place work prior to final acceptance.

The speed of the bituminous paver shall be controlled to lay the mixture uniformly and continuously without tearing or gouging. The paver's speed shall not exceed the manufacturer's recommendation and shall be coordinated with the output of the plant to provide for a smooth, continuous operation with the paver.

All transverse and longitudinal joints, high or low areas, and surface irregularities shall be leveled, filled, or raked before compaction. Loose material shall be removed from previously compacted lanes or joints before compacting adjacent lanes.

Paving operations shall be conducted to minimize the inconvenience to traffic and protect existing and finished surfaces. Placing bituminous mixture shall progress so a single lane is not more than 1 day's run in advance of any adjacent lane. Altering the sequence of paving operations to best suit construction conditions may be required. The Contractor shall not permit two-way traffic past the machine laydown operation and 1-way traffic without the use of a Contractor-furnished pilot car.

A tack coat shall be applied on a previously placed layer or surface of pavement before spreading the next layer.

Hot bituminous pavement shall not be placed on bridge decks unless specified.

When required, the Contractor shall excavate locations where the new surfacing meets existing pavement, bridge ends, or railroad crossings to allow full depth placement of the surfacing course. If excavation is required, it will be paid according to Section 104.03.

Rumble strips, when specified, shall be milled into asphalt shoulders and be placed in a continuous pattern. Rumble strips will be discontinued across the full width of all public and private (residential and commercial) road approaches, entrance and exit ramps, and within designated city or urban limits. Rumble strips will not be installed on shoulders less than 4 feet in width.

I. **Compaction.**

1. **General.** Except for shoulders, driveways, section line approaches, leveling courses and patching, the bituminous mixture shall be compacted according to Section 408.04 I.3, Specified Density.

The sequence of rolling operations and the selection of type and number of rollers shall be commensurate with production and shall be adequate to attain the specified density before the mat temperatures falls below 185°F. The compaction equipment for mainline paving shall include not less than one Self-Propelled Pneumatic-Tired Roller and one Smooth-Faced Steel-Wheel Roller: Tandem - Type A, Smooth-Faced Steel-Wheel roller: Tandem - Type B or Vibratory Roller conforming to Sections 151.02 B, C.2, C.3, C.4, or D. A combination roller meeting the requirements of Section 151.02 E may be

used in lieu of the pneumatic-tired and vibratory roller. The Engineer has the option to remove the pneumatic-tired roller if compaction can be achieved without the equipment.

Rolling shall begin at the edges and proceed parallel to the road centerline with each trip overlapping the previous roller pass, and progressing to the crown of the road. When paving in echelon or abutting a previously placed lane, the longitudinal joint should be rolled first followed by the regular rolling procedure. On super-elevated curves, the rolling shall begin at the low side and progress to the high side by overlapping of longitudinal trips parallel to the centerline. Displacement resulting from reversing the direction of a roller, or from other causes, shall be corrected immediately with rakes and the addition of fresh mix. Care shall be exercised in rolling edges of the bituminous mixture so line and grade of the edge is maintained.

In areas not accessible to rollers such as along forms, curbs, headers, and walls, the mixture shall be thoroughly compacted with hand or mechanical tampers.

Any mixture that becomes loose and broken, mixed with dirt, shows any excess or deficiency of bitumen, or is defective in any manner, shall be removed and replaced with fresh hot mixture, and compacted to the density of the surrounding area.

2. **Ordinary Compaction.** Ordinary Compaction shall be used on shoulders, driveways, section line approaches, bike paths, leveling courses and patching projects.

The testing, Contractor coring and compaction payment schedule specified in Section 408.05 C will not apply for leveling courses, patching, and bike paths.

When specified density on mainline is required, the laboratory testing requirements in Section 408.05 C.1 will apply for shoulders, driveways, and section line approaches. The contractor coring and compaction payment schedule in Section 408.05 C.2 and 408.05 C.3 will not apply.

Compaction consists of initial or breakdown rolling, intermediate rolling, and final or finish rolling.

Breakdown rolling shall consist of one or more complete coverages with a roller meeting the requirements of Sections 151.02 B, 151.02 C.2, or 151.02 D.

Breakdown rolling shall be followed by intermediate rolling with a roller conforming to Section 151.02 B until the surface is tightly bound and shows no displacement under the roller. Intermediate rolling shall be completed before the mat temperature falls below 185°F. The Engineer has the option to remove the pneumatic-tired roller if compaction can be achieved without, and there is a problem with the tires picking up or with roller marks in the mat.

The final rolling shall be performed with a roller conforming to Section 151.02 C.3 or 151.02 D in the static mode, and shall continue until roller marks are eliminated.

The Contractor may be required to modify the rolling sequence to best suit construction conditions.

When compacting leveling courses and patches spread with motor graders the initial rolling shall be by pneumatic-tired rollers done simultaneously with the spreading. Additional pneumatic-tired rollers required for obtaining compaction shall conform to Section 151.02 B. The roller specified for final rolling may be omitted with approval of the Engineer. The desired degree of compaction will be considered obtained when the surface is tightly bound and shows no displacement under operation of the roller.

3. **Specified Density.** This method provides for compacting bituminous mixture on interstate crossroads, ramps, rest area approaches, parking lots, and mainline pavement according to the density requirements specified in Section 408.05 C.

Bituminous mixture placed on shoulders, driveways, and section line approaches are exempt from the specified density requirements. Such mixtures shall be compacted to the satisfaction of the Engineer with the same rollers and rolling sequences used on the mainline. In confined areas, other rollers may be used, as approved by the Engineer.

- J. **Joints.** Joints shall be tacked and constructed with adequate bond on abutting surfaces. Vertical construction joints in successive courses shall be placed so the joints do not fall in the same vertical plane.

Pavement placed against the surface of curbing, gutters, manholes, and similar structures shall be placed uniformly high near the contact surfaces so the pavement is slightly higher than the edge of the structure after compaction.

- K. **Maintaining Completed Course.** Upon completion of the final rolling and finishing, surface maintenance required due to construction operations shall be at the Contractor's expense until the next or final surface is placed or until the work has been accepted by the Department. Maintenance shall include the removing, replacing, reshaping, and recompacting of damaged areas.
- L. **Tolerances.** The surface shall be smooth, uniform, and true to Plan crown, alignment, and grade. Surfacing thicknesses shown on the typical sections are minimum and the estimated plan tonnages shall be used uniformly throughout the Project.

Any low or high defective areas shall be corrected as directed by the Engineer. Corrective work shall include patching or cutting out the surface and replacing with fresh hot bituminous mixture, or by milling the surface. The surface of the finished pavement shall be free from irregularities exceeding 3/16 inch as measured with a 16-foot straightedge parallel and perpendicular to the centerline of the roadway.

Deficiencies in smoothness, improperly constructed joints, and surface irregularities shall be corrected with a second diagonal rolling crossing the line of the first at the Contractor's expense.

- M. **Limitations.**

1. **Weather.** Hot bituminous mix shall not be placed on a damp surface, on a frozen roadbed, or when weather conditions prevent the proper handling or finishing of the bituminous mixtures. Presence of frost particles in the roadbed is

sufficient evidence of being frozen. Hot bituminous mix shall not be placed when the air or mat surface temperatures are below the following minimums:

AIR TEMPERATURE

Compacted Thickness	Air Temperature Surface Course	Subsurface Course and Approaches	Existing Mat Temperature*
1-1/2" or less	45°F.	40°F.	40°F.
More than 1-1/2"	40°F.	35°F.	40°F.

*Existing mat temperature will be measured with an infrared sensing thermometer or by a conventional thermometer inserted into a 1-inch deep hole in the pavement and filled with water, oil, or grease.

2. **Operational.** Traffic shall not be permitted on the completed surfacing until the lift has been compacted and has cooled sufficiently to prevent damage.
- N. **Bituminous Pavement Sloughs.** Bituminous pavement sloughs shall be compacted with rollers capable of providing a smooth finished compacted slough that is free of tire marks and unevenness or drop-off. Density tests are not required.
- O. **Superpave.** All criteria for shall follow Section 408. Testing methods shall follow the procedures of the Department's *Field Sampling and Testing Manual*.

408.05 ACCEPTANCE.

The aggregate gradation pay factor in Section 408.05 A.1. and the bitumen uniformity requirements in Section 408.05 B.2 will not apply when the total plan quantity of hot bituminous pavement is 4,000 ton or less. When the total Plan quantity of hot bituminous pavement is 4,000 ton or less the material will be accepted according to Section 105.07.

A. Aggregate.

1. **Gradation.** Aggregate will be sampled and tested in lot sizes equal to the number of tons produced. One aggregate sample will be tested for each 1,500 ton of mix produced with a minimum of one sample per day. Payment for the mix represented by the samples will be based on the uniformity of the test results.

The Contractor shall obtain all aggregate samples at random times determined by and under the observation of the Engineer. The samples shall be taken from the cold feed belt according to AASHTO T 2, Section 4.3.1 or 4.3.2. The sample shall be split into two representative samples, numbered and bagged by the Contractor under the observation of the Engineer. Both halves of the sample shall be submitted to the Engineer. The untested half of the sample will be retained by the Engineer for 24 hours after the test results are made known to the Contractor. Either party may request that the second half of the sample be tested within this 24-hour time frame. The test results from this re-test shall replace the test values of the initial test.

If any two tests in a lot result in the variance of any one or more sieves from the JMF gradation target value by more than the tolerances listed below, a de-

duction on the entire lot will be applied. A deduction will be calculated for each sieve out of the acceptable range. The total deduction will be the sum of the deductions calculated for each sieve out of the acceptable range. The Pay Factor for the aggregate material will be adjusted according to the following formula:

$$\text{Pay Factor} = \frac{100 - \text{Deviation from the Target Range}^*}{100}$$

$$\text{Lot Pay Factor} = 100 - \sum (\text{Deduction})$$

*Target Range = target value + or - the acceptable tolerance value listed below:

AGGREGATE TOLERANCES

5/8 sieve ¹	+ 2%
1/2" - #8 sieve ²	± 7%
#16 - #50 sieve ²	± 6%
#200 sieve ²	± 2%

¹Providing all material passes the 3/4-inch sieve.

²The target value + or - the tolerance allowed shall not exceed the specified gradation range.

The deduction will be waived by the Engineer if; the daily air voids of the marshall plugs as determined in Section 408.05 C.1 are between 3 and 5 percent and the aggregate gradation for each sieve is not outside the gradation band for the class of aggregate specified. If both of these conditions are met, the Lot Pay Factor will be 1.00.

If the material fails to meet the specifications for two consecutive lots, the Contractor shall not incorporate any additional material into the work until the Engineer is satisfied that the Contractor is taking necessary corrective action to meet the Specifications. The Engineer may request that a new mix design be developed if the Contractor is unable to meet the Specifications.

2. **Additional Aggregate Tests.** Aggregate samples to determine shale content, plasticity index, fractured faces, and L. A. Abrasion loss will be taken by the Contractor, under the observation of the Engineer, before the addition of bitumen to the mix.

The shale content and plasticity index of the aggregate will be determined by the average of test results from three random samples taken from the cold feed belt from each lot of 10,000 tons or fraction thereof. The samples will be tested and the material will be accepted if the average of the three samples meets the specified requirements. If each of the samples is within the specified limits, only one of the three samples will be tested from each subsequent lot. If at any time the sample tested does not meet the specified requirements, the remaining two samples will be tested. The average of these three samples will then be used to determine acceptance of the material. The testing of three samples per lot will continue until all three samples are within the specified limits, then only one of the three samples will be tested from each subsequent lot. If the average exceeds the specified maximum for shale content, the unit price for the bituminous mixture will be adjusted according to Section 408.07 B.

If the average fails to meet the specified requirements for plasticity, the material will be rejected, unless the Engineer elects to accept it under Section 105.07.

The L. A. Abrasion loss percentage of aggregate will be determined on the basis of 1 composite aggregate sample taken and tested during the beginning of the aggregate stockpiling. If this percentage exceeds the maximum allowable loss, the material will not be accepted.

The percentage of fractured faces for course aggregates will be determined by the average of test results from three random samples taken from the cold feed belt for each lot of 10,000 tons of bituminous mixture produced. The samples will be tested and the material will be accepted if the average of the three samples meets the specified requirements. If each of the samples is within the specified limits, only one of the three samples will be tested from each subsequent lot. If at any time the sample tested does not meet the specified requirements, the remaining two samples will be tested. The average of these three samples will then be used to determine acceptance of the material. The testing of three samples per lot will continue until all three samples are within the specified limits, then only one of the three samples will be tested from each subsequent lot. If the average fails to meet the specified requirements, the material will be rejected unless the Engineer elects to accept it under Section 105.07.

- B. **Bitumen Content.** The required bitumen content, or target percentage, will be designated by the Engineer.

The quantity of bitumen used and paid for from each lot will be determined by the use of daily oil cutoffs following the procedures outlined on the Mix Bitumen Cutoff Report. A lot shall be defined as the amount of bitumen used each production day.

The pay factor for the hot bituminous pavement, adjusted for bitumen content, will be the lowest pay factor determined by both of the following methods:

1. **Average.** If the daily cutoff, as determined on the Mix Bitumen Cutoff Report, deviates from the target percentage set by the Engineer by more than 0.24 percentage points the pay factor will be determined from the following table:

BITUMEN CONTENT

Pay Factor	Deviation from Target in Percentage Points
1.00	0.00-0.24
0.98	0.25-0.29
0.95	0.30-0.34
0.92	0.35-0.39
*	0.40 & Over

*The Engineer will determine the pay factor according to Section 105.07.

2. **Uniformity.** The Engineer will check the asphalt content each time an aggregate sample is taken. The checks will be based on readings from the totalizers

for the aggregate and the bitumen as outlined in the Asphalt Content Determination Report. If the asphalt content from any random reading varies from the daily average of the readings by more than 0.24 percentage points, the pay factor for the hot bituminous material will be adjusted according to the following formula:

$$\text{Pay Factor} = \frac{100 - [20 (* \text{Deviation} - 0.24)]}{100}$$

*Deviation from the average daily asphalt content.

C. Compaction.

1. **Testing.** The compaction of the mixture will be accepted in lot sizes equal to the number of tons placed each production day. The density of the pavement will be determined from cores obtained by the Contractor, as specified in Section 408.05 C.2.

Each subplot will be one paver width wide, excluding the shoulders, 2,000 feet long, and of the depth specified for the pavement course. If the partial subplot remaining at the end of a production day is 1,000 feet in length or longer, it will be considered a separate subplot. If it is less than 1,000 feet long, it will be included in the last complete subplot. If the total day's production is less than 2,000 feet long (one paver width wide), that production will be considered a lot.

The mean density of the mainline pavement placed each production day will be the average of the densities of all of that day's sublots. In addition to testing randomly selected locations, the Engineer reserves the right to direct the testing of any areas which appear defective. Defective areas will be rejected unless the Engineer elects to accept it under Section 105.07.

The Contractor, under the observation of the Engineer, shall:

- a. Obtain mix samples from behind the paver at random times specified by the Engineer. One sample shall be taken each time an aggregate sample is taken; and
- b. Compact 3 marshall specimens with each sample taken to determine the field marshall density. The number of blows applied to the marshall specimens shall be 50, unless otherwise specified, and the temperature of the mix shall be 270 plus or minus 5°F; and
- c. Determine the Maximum Theoretical Density of each sample taken.

The methods used to obtain the samples, compact the marshall specimens and determine the Maximum Theoretical Density shall be as outlined in the Department's *Field Sampling and Testing Manual*.

For a project on an NHS route, the Engineer will do acceptance testing according to Appendix G of the Department's *Field Sampling and Testing Manual*.

2. **Contractor Coring.** The Contractor shall take two cores in each subplot at a random location determined by the Engineer and under the observation of the

Engineer. After coring and sawing, the cores shall be handed over to the Engineer. The cores shall be taken adjacent to each other and the average of the two cores shall be used for determining the density of the subplot.

The Contractor shall take one additional full-depth core per mile, under the observation of the Engineer, with one location in each lane, for the District Materials Coordinator to use as an independent assurance test. The District Materials Coordinator will determine the locations of these cores. The cores shall not be sawed by the Contractor.

The coring machine shall cut a cylindrical sample in the compacted asphalt lift without disturbing the density of the sample. The core samples shall be 4 to 6 inches in diameter. The masonry saw shall cut the core sample so only the compacted layer to be tested is removed; and the core is in a condition suitable for testing.

Coring of each day's paving shall be completed no later than the next working day following the placement of the lift. Cores shall be taken through the full depth of the in-place asphalt pavement. The surface of the outside of the cores shall be smooth with no distortion of the cylindrical shape or displacement of the aggregate particles. A masonry saw shall be used to remove the compacted layer from the full-depth core without damaging the newly placed asphalt material.

The Contractor shall fill all holes remaining in the surface of the roadway with bituminous material and compact the material as directed by the Engineer. Each core shall be numbered or lettered to identify the location from which the core was taken. The marking system shall meet the approval of the Engineer.

The Contractor may elect to take a check sample, at the Contractor's expense, whenever the average density of a set of cores is 89 percent or less than the Theoretical Maximum Density. A check sample shall be a set of cores taken within 2 feet of the location of the failing set of cores. The average density of the check sample cores will be the result used to determine the Unit Price of the hot bituminous pavement.

Retests and additional tests will not be taken or paid for unless approved by, or directed by, the Engineer.

The Contractor shall control traffic according to the traffic control plan to ensure the safety of the coring crew and the traveling public. The Engineer may alter these requirements depending on the location of the coring operation in respect to the existing traffic control zone, and in situations where traffic is being controlled by a pilot car and/or flaggers. Coring operations shall not take place adjacent to the paver to avoid blocking traffic.

3. **Compaction Payment Schedule.**

Acceptance of mainline pavement placed on any production day will be based on the average density of the pavement compared to the daily average maximum theoretical density (MTD) determined for each lot of pavement placed. The average density of the field cores shall be at least 91 percent of the

daily average MTD. Each individual subplot shall have an average density of at least 89 percent of the daily average MTD. If the average density of the field cores is less than 91 percent of the daily average MTD or any subplot is less than 89 percent of the daily average MTD the Unit Price of the hot bituminous pavement will be adjusted according to the following tables:

**PAVEMENT DENSITY
ADJUSTMENT OF UNIT BID PRICE PER LOT**

Pay Factor A	Average Pavement Density
1.00	91% or greater
0.99	90.0% - 90.9%
0.975	89.0% - 89.9%
0.95	88.0% - 88.9%
0.925	87.0% - 87.9%
*	Less than 87.0%
 Pay Factor B	 Lowest Density of any Sublot
1.00	89% or greater
0.99	88.0% - 88.9%
0.98	87.0% - 87.9%
0.97	86.0% - 86.9%
0.96	85.0% - 85.9%
*	Less than 85.0%

*The Engineer will determine whether the material may remain in place. The Pay Factor for the material allowed to remain in place shall be .70 for Pay Factor A and .80 for Pay Factor B.

The density of the field cores will be determined according to the procedures of the Department's *Field Sampling and Testing Manual*. The Total Pay Factor will be the product of the pay factor for the average pavement density and the lowest subplot.

$$\text{TOTAL PAY FACTOR} = (\text{PAY FACTOR A}) \times (\text{PAY FACTOR B})$$

408.06 METHOD OF MEASUREMENT.

The estimated quantities provided may be adjusted by the Engineer in the field. Any increase or decrease in the quantities used shall not be a basis for renegotiation in the price bid for these items.

- A. **Hot Bituminous Pavement.** Hot Bituminous Pavement will be measured by the Ton or Square Yard according to Section 109. Batch weights will not be permitted as a method of measurement unless the plant is equipped with an automatic batching and weighing system with an automatic printer system which prints the weights of each batch and issues a weigh ticket for each load. The Tonnage will be the weight used in the accepted pavement and no deduction will be made for the weight of bitumen used in the mixture.
- B. **Bitumen.** Bitumen will be measured according to Section 109 and the quantity of bitumen will be the number of Tons or Gallons used in the accepted work.

- C. **Cored Sample.** Each individual cored sample that is removed in the required condition will be measured as a unit. The work vehicle, coring machine, masonry saw, and the shadow vehicle will not be measured for payment, but will be included in the measurement of the cored sample.
- D. **Rumble Strips.** When a bid item is included in the Plans, the quantity for rumble strips is determined by project length for each shoulder per mile. The quantity paid for will be the quantity shown in the Contract, provided the project is constructed as shown in the Plans. A deduction in length will not be made for discontinued rumble strips across road approaches, ramps, etc. as identified in the notes in the standard drawings.

When the bid item for rumble strips is each, payment will be for all rumble strips installed at a stop intersection in one lane.

408.07 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Hot Bituminous Pavement	Ton
Asphalt Cement	Ton or Gallon
Superpave, FAA 40	Ton
Superpave, FAA 41	Ton
Superpave, FAA 42	Ton
Superpave, FAA 43	Ton
Superpave, FAA 44	Ton
Superpave, FAA 45	Ton
Cored Sample	Each
Rumble Strips	Each or Mile

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

When price adjustments are required for failing material or patching, payment will be made as follows:

- A. Determination of the payment adjustment of a lot of bituminous mixture will be made by successively multiplying the Contract Unit Price per Ton of the bid item by the applicable pay factors as determined in Sections 408.05 A, 408.05 B, and 408.05 C.
- B. When the average of the test results specified in Section 408.05 A.2 shows a larger shale content than the maximum allowable specified, the following deduction from the Bid Price for the bituminous mixture item will be made:

One percent reduction in unit price for each 0.2 percent above the maximum allowable percentage. If the percentage of shale exceeds the allowable limits by 2 percent or more, the material will be rejected unless the Engineer elects to accept it under Section 105.07.

This reduction will apply to lots of 10,000 tons, and will be applied independently of Section 408.05 A.1.

- C. Material for patching or leveling of an existing bituminous surface constructed under a previous Contract shall be obtained from the tonnage provided in the basis of estimate and will be paid according to the following provisions:
1. For all leveling and patching when no excavation is required, payment will be made at the Contract Unit Prices for the materials used in the repair.
 2. When the patching requires excavation, the method and site of disposal of the waste materials shall be subject to the approval of the Engineer, and:
 - a. If the excavated material is disposed of within the Right of Way adjacent to the work site, payment for the bituminous mixture used in the repair will be made per Ton as follows: Contract Unit Price plus the price per Ton listed in the "Price Schedule PS-1."
 - b. If the excavated material is loaded and hauled to a disposal area not adjacent to the work site, payment for the bituminous mixture used in the repair will be made per Ton as follows: Contract Unit Price plus the price per Ton listed in the "Price Schedule PS-1."
 - c. If aggregate is required to replace excavated material in the existing base or subgrade, payment for the class of aggregate used will be made under Section 104.03. Payment will include disposal of excavated material, and the furnishing, placing, and compacting of the aggregate.
 - d. Payment for prime, tack, and the bitumen in the mix used in the repair will be made at the Contract Unit Prices for those items.

**SECTION 409
HOT BITUMINOUS PAVEMENT
QUALITY CONTROL/QUALITY ASSURANCE**

409.01 DESCRIPTION.

This work shall consist of constructing one or more courses of bituminous pavement on a prepared surface for Quality Control/Quality Assurance (QC/QA) projects. The Contractor shall be responsible for process control, and shall perform the necessary testing to control the quality of the work. When specified on the plans the contractor shall develop a mix design.

409.02 MATERIALS.

- A. **Bitumen.** The bitumen shall meet Section 818 and will be of the type and grade specified in the Contract. Bitumen will be accepted as outlined in the Combined State Binder Group agreement for North Dakota. Samples will be obtained by the

Contractor under the observation of the Engineer, and immediately handed over to the Engineer for shipping and testing.

- B. **Aggregate.** The Aggregate Gradation Master Range for the class of aggregate specified shall conform to the following requirements:

Sieve Size	Percent Passing
5/8 in.*	100
1/2 in.	90 - 100
No. 4	45 - 80
No. 30	10 - 35
No. 200	2.0 - 7.0

* A tolerance of 2 percent in the amount passing the 5/8-inch sieve will be permitted providing all material passes the 3/4-inch sieve.

The gradation values listed are the extreme limits for design purposes. During Production mixture tolerance on all sieves, may fall outside the aggregate master range, except on the 200 sieve. The remaining physical properties, (lightweight pieces, P.I., fractured faces, etc.) for the class of aggregate specified, shall be as specified in Section 816.03 of the Standard Specifications.

409.03 EQUIPMENT.

Equipment shall be as specified in Section 408.03.

409.04 CONSTRUCTION REQUIREMENTS.

Contractor Quality Control. Quality Control (QC) will be the responsibility of the Contractor. The Contractor will perform quality control sampling, testing, and inspection during all phases of the work at a rate sufficient to assure that the work conforms to the Contract requirements. The Contractor shall have at least one person on the Project, at all times, who is certified as a Asphalt Mix Controller and one person certified as an aggregate lab and asphalt mix tester. The inspector shall be certified as an Asphalt Pavement Inspector. Certification requirements will be as outlined in the Department's Transportation Certification Program (TCP).

Quality Control Plan. Prior to beginning work the Contractor will submit a "Quality Control Plan" to the Engineer. The Plan will contain: 1) the names and phone numbers of the individual(s) responsible for the Contractor's quality control program; 2) a listing of the technician(s) responsible for the quality control testing; 3) an organizational chart indicating lines of authority (including names and phone numbers); 4) a summary of the qualifications of the Quality Control Technicians; and 5) details of the Contractor's quality control plan addressing but not limited to the following items: 1) pit operations and methods used to control uniformity, reducing segregation, and efficiently utilizing the aggregate resources of the pit; 2) plant operations discussing proposed equipment (number of bins, plant type, etc.) and method of operations; 3) testing frequency and how this meets the intent of the Specification; and 4) discussion of how the Contractor's quality control program will respond to the need for corrective action as defined in Section 409.04 O.2.

The Department will provide the Contractor with: 1) the names and phone numbers of the individual(s) responsible for project administration; 2) a listing of the technician(s)

responsible for the quality assurance testing; and 3) an organizational chart indicating lines of authority (including names and phone numbers).

Quality Control Laboratory. The Contractor will furnish and maintain a Type C laboratory at the plant as specified in Section 706 of the Standard Specifications. Any other laboratory location must be approved by the Engineer. The laboratory will be furnished with the necessary equipment and supplies for performing the Contractor mix design if called for on the plans and for the contractor QC testing. During production of the aggregate, the Contractor may furnish a lab equipped with the necessary equipment to perform the following aggregate tests: bulk and apparent specific gravity, gradation analysis, lightweight pieces of aggregate, plastic index, and fractured faces. The Type C laboratory must be set up and ready to use before the paving operation begins. This laboratory will be measured and paid according to Section 706.02 C.

The Contractor will provide an aggregate lab and asphalt mix tester, as outlined in the Department's TCP, to perform all testing including all testing performed during aggregate production. The Contractor shall also provide testing equipment that meets the requirements for all tests called for by Specifications.

Engineer's Laboratory. The Contractor will provide an additional Type C laboratory to be used during actual mix production by the Department's aggregate lab and asphalt mix tester. The testing equipment will be provided by the Department. The lab will be set up at the plant prior to production of the bituminous mix and be made available to the Engineer for Quality Assurance testing. The Contractor and the Engineer will share the Triple Hammer provided for the Contractor's lab.

A. **Pit Operations and Stockpiling of Aggregate.** During production of the aggregate, the aggregate will be tested for gradation, plastic index, fractured faces, and lightweight pieces of aggregate. The testing frequency for gradation will be one test per 1,000 tons of material produced for each aggregate stockpile. The testing frequency for the plastic index, fractured faces, and lightweight pieces of aggregate will be the average of three random composite samples from the first 5,000 tons of material produced. If all three samples pass, the testing frequency will change to one of three samples tested for each 10,000 tons of material produced. If a sample fails, the remaining two samples will be tested and averaged for acceptance of that lot. The testing frequency will then revert to the average of three tests per 5,000 tons until all three samples pass, then one of three samples will be tested for each 10,000 tons.

After 10,000 tons of material is produced, the Contractor will provide the Department with an aggregate sample representing each stockpile and asphalt required for the mix design. The Contractor shall develop a preliminary mix design and submit the results to the Department. This mix design is for informational purposes to assure the Contractor has produced specified material. The Contractor shall provide all of the information required for the JMF, except the stability of the mix. The mix design will be developed according to the Department's *Field Sampling and Testing Manual* and will meet the requirements specified in Section 409.04 B.

The Contractor will sample and test the aggregate according to the Department's *Field Sampling and Testing Manual*.

The Contractor shall provide the Engineer with copies of the test results for each stockpile of aggregate that will be incorporated into the mix within 48 hours of

sample collection. The test reports will include results for gradation, plastic index, fractured faces, lightweight pieces of aggregate and the bulk and apparent specific gravity.

During the first week of aggregate production, for each class of aggregate, as soon as the Contractor determines the aggregate is representative, and prior to the initial mix design, the Contractor shall obtain a 90-pound sample of each aggregate component. The Contractor shall split the samples under the observation of the Engineer. One-half of each aggregate sample will be submitted to the Engineer for testing. The Contractor and the Engineer will test the samples to determine the bulk (dry) and apparent specific gravity and the percent water absorption by dry weight of aggregate. The testing will be completed according to AASHTO T 84, T 85 and the procedures in the Department's *Field Sampling and Testing Manual*. One test will be performed for each 10,000 ton of each aggregate component produced. A minimum of two tests will be required for each aggregate component. Testing shall commence within two working days of sampling. Test results will be reported to each party as soon as they are available.

If the individual specific gravity values determined by the Contractor and the Department correlate within 0.040, the average of the Contractor's numbers will be used to calculate the absorption, fines to asphalt ratio, and voids in mineral aggregate (VMA). If the individual specific gravity values determined by the Contractor and Department do not correlate within the allowable tolerance (0.040), or if the Contractor fails to supply an aggregate that meets the mix design criteria then:

1. The mix design will not be approved and mix production will not begin.
2. The Contractor has the option of running the test together with Department personnel at the District Lab and use those results, or testing differences can be resolved according to the procedures in the Department's *Field Sampling and Testing Manual*.

If the Department's mix design meets the properties specified and the Department and the Contractor mutually agree it is necessary to adjust the aggregate production operation to produce an aggregate that will improve the mix design properties, the Department will negotiate an equitable adjustment with the Contractor to produce an aggregate that meets the desired mix design properties.

- B. Mix Design.** The mix design used will be a lab mix design developed by the Department or determined by the Contractor and approved by the Department. The mix design will be developed according to the Department's Mix Design Procedure. The mix design will be developed using the type, grade and source of asphalt that will be used on the project. The target value for each sieve for the mix design shall be the average of production samples multiplied by the percentage of material used in the blend proportion. The blended sample will be used for the mix design if the gradations obtained from the blended sample are within the tolerances listed in Table C when compared to the target values. The mix design will meet the following properties for the type of mix specified:

Mix Criteria	CLASS 27				CLASS 29				CLASS 31				CLASS 33			
	Top or wearing course		Bottom or non-wearing course		Top or wearing course		Bottom or non-wearing course		Top or wearing course		Bottom or non-wearing course		Top or wearing course		Bottom or non-wearing course	
	Min	Max	Min	Max												
Blows to Marshall Plug	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Stability (lbs.) ¹	1200		1200		1500		1500		1650		1650		1800		1800	
Flow, 0.01 in.	8	18	8	18	8	18	8	18	8	16	8	16	8	16	8	16
Percent VMA ²	14.0	16.0	14.0	16.0	14.0	16.0	14.0	16.0	14.0	16.0	14.0	16.0	14.0	16.0	14.0	16.0
Fines/Asphalt Ratio ³	0.6	1.3	0.6	1.4	0.6	1.3	0.6	1.4	0.6	1.3	0.6	1.4	0.6	1.3	0.6	1.4

¹Desired minimum value, the Engineer will evaluate the actual value determined in the mix design.

²Voids in Mineral Aggregate (VMA).

³Required Range, the fines/asphalt ratio shall be determined by dividing the percentage of material passing the #200 sieve by the percentage of effective asphalt added to the mix. The percentage of asphalt used will be as determined in the Mix Design at 4 percent air voids. The effective asphalt will be determined as follows: (The formula is as defined in Manual Series No. 2 published by the Asphalt Institute.)

$$AC_{\text{effec}} (\text{Mix Basis}) = \%AC - \left\{ \frac{\% \text{Absorbed AC by weight of aggregate} \times \% \text{Aggregate in mix}}{100} \right\}$$

Perform calculations to the nearest hundredth and round to the nearest tenth.

1. The Department's Developed Mix Design.

The Contractor will provide the Engineer with an aggregate sample representing each stockpile as specified previously. A sample tag identifying the project number, pit location, and class of aggregate shall be attached to the sample. The total weight of the combined sample will be approximately 150 pounds and meet the gradation of the class of aggregate specified.

The Contractor will also provide eight 1-quart cans of bitumen of the type and grade specified in the Plans. The bitumen will meet all requirements of Section 818 and will be from the supplier the Contractor uses for the project.

The Contractor will submit the aggregate sample, the blend proportions, the average production sample results, and the type, grade, AC specific gravity, and name of the supplier of the bitumen in writing with the submission of the samples. The aggregate and bitumen samples will be submitted a minimum of seven working days before the start of the planned paving operations.

If aggregate or asphalt is utilized from sources other than those initially submitted, the aggregate is processed using a different crusher, or if a different type or grade of asphalt is used, the Contractor shall notify the Engineer in writing five days before incorporating the material into the work. If the Engineer determines that a new mix design is required, the Contractor shall pro-

vide a sample of the material to the Engineer and allow the Department 3 working days to prepare a new mix design. If the Contractor fails to provide a timely sample, the Contractor shall cease operations and allow the Department three working days to prepare a new mix design.

The target value for each sieve for the mix design shall be the average of production samples multiplied by the percentage of material used in the blend proportion. The Department will blend the aggregate at the blend proportions specified by the contractor. The blended sample will be used for the mix design if the gradations obtained from the blended sample are within the tolerances listed in Table A when compared to the target values determined previously. If the aggregate is not within tolerance a mix design will not be developed.

2. Contractor Developed Mix Design.

After the Contractor has sufficient material produced to assure uniform production of each aggregate component, a mix design or series of mix designs shall be performed until a mix design is developed meeting all the requirements specified. The Contractor shall submit the completed mix design including all test data to the appropriate District Materials Laboratory.

The final mix design report shall be submitted using a Department-approved computer format. The Contractor shall also submit sufficient amount of individual aggregate components and asphalt. The aggregate and asphalt will have the same properties as was used for the Contractor's mix design.

The Contractor's mix design will be reviewed within five working days.

If the Department's verification confirms the results of the Contractor's mix design are within the tolerances specified in Table C, the Contractor's mix design will be approved. The tolerance for Maximum Specific Gravity shall not be determined in Table C, but shall be ± 0.30 percent. If the Contractor's mix design is not approved, the Contractor shall submit another mix design. An approved mix design will be required prior to beginning production of hot bituminous pavement.

If aggregate or asphalt is utilized from sources other than those initially submitted, the aggregate is processed using a different crusher, or if a different type or grade of asphalt is used, the Contractor shall notify the Engineer in writing five days before incorporating the material into the work. If the Engineer determines that a new mix design is required, the Contractor will develop another mix design and submit it for approval with the same information as required for the initial mix design, before incorporating this material into the mixture. If the Contractor fails to submit an approved mix design and provide timely samples, the Contractor will cease operations until an approved mix design is developed.

The result of the mix design process is the Job Mix Formula (JMF), and will contain the following:

- a. The percentage of aggregate passing each of the specified sieves.
- b. The percent asphalt cement to be added to the mixture.

- c. The target air voids will be 4 percent.
- d. The maximum specific gravity of the mixture obtained in the laboratory.
- e. The bulk specific gravity of the mixture obtained in the laboratory.
- f. The percent VMA of the mixture obtained in the laboratory.
- g. The stability of the mix.
- h. The fines/asphalt ratio.
- i. The asphalt film thickness.

Determination of Surface Area

Sieve Analysis Percent Passing								
Sieve	Max. Size	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200
Combined Grading	***	***	***	***	***	***	***	***
Coefficient	0.02	0.02	0.04	0.08	0.14	0.30	0.60	1.60

* Film Thickness $FT = \frac{(Pbe)(4885)}{(100)(SA)}$

Where: Pb = asphalt cement, percent, mixture basis
 Pba = percent AC absorbed by weight of aggregate
 Ps = aggregate, percent mixture basis
 Pbe = effective asphalt content, percent, mixture basis
 FT = film thickness (Microns)
 SA = surface area (ft²/lb)

**The Dust/Effective asphalt ratio shall be determined by dividing the percentage of material passing the #200 sieve by the percentage of effective asphalt added to the mix. The percentage of asphalt used will be as determined in the Mix Design at 4 percent air voids.

The effective asphalt will be determined as follows: (The formula is as defined in Manual Series No. 2 published by the Asphalt Institute.)

$$Pbe = Pb - \frac{(Pba)(Ps)}{100}$$

***The gradation used for calculating film thickness and dust/effective A.C. ratio will be the combined gradation results of the actual material used to run the mix design. Perform calculations to the nearest hundredth and round to the nearest tenth.

(Sections C through N are specified in the respective sections of 408.04)

O. **Quality Control Sampling and Testing.** During production of the bituminous mix, the Contractor will be required to perform random sampling and testing on the aggregate and bituminous mix as the mix is being produced and placed on the roadway. All test results will be provided to the Engineer by noon the following day.

The Contractor will sample and test the bituminous mix as outlined in the Department's *Field Sampling and Testing Manual*.

The Contractor will sample the aggregate from the cold feed and test the aggregate using the Department's sampling and testing procedures. The sieve analysis will

be performed using all of the sieves required for the determination of the asphalt film thickness. The tests will be performed at the frequency specified in Table A below:

**TABLE A
QUALITY CONTROL TESTING FREQUENCIES**

Test	Daily Frequency
Gradation (use all sieves for Cl. specified)	1/1500 tons
Plastic Index ¹	3/10,000 tons
Lightweight pieces of aggregate ¹	3/10,000 tons
Fractured Faces ¹	3/10,000 tons
Maximum Sp. Gr. of Bit. Mix (Rice Method)	1/1500 tons
Bulk Sp. Gr. of Bit. Mix (Plugs) & Air Voids	1/1500 tons
Percent Asphalt Cement	1/1500 tons ²

¹ The content of the lightweight pieces of aggregate, plastic index, and fractured faces of the aggregate will be determined by the average of test results from three random samples taken from the cold feed belt for each lot of 10,000 tons or fraction thereof. If all samples pass, only one of the three samples taken will be tested until a sample fails; then the remaining two samples will be tested and averaged for the acceptance of that lot. The testing of three samples per lot will continue until all three samples pass, then one of the three samples will be tested from each lot.

² The Contractor will make random checks of the asphalt content each time a gradation test is taken under the observation of the Engineer. The random checks will be based on readings from the totalizers for the aggregate and the bitumen as outlined in the Department's Asphalt Content Determination Report.

The Contractor will split and identify all samples. The split samples will be retained by the Contractor for Independent Assurance testing by the District Materials Laboratory. The samples to be tested by the Contractor and the split samples given to the Engineer will be large enough to be split again, such that four samples are available for testing. The split samples of aggregate will be stored in a dry, protected location until picked up by the Engineer. The mix samples taken to determine the maximum specific gravity will be split after the sample has been allowed to cool.

When quality control samples indicate uniform results on Plastic Index, Lightweight Pieces of Aggregate, or Fractured Face Tests; and both parties are confident that future production will remain within the specifications, the Engineer, by written notice, may reduce the frequency of the tests.

- Control Limits.** The Contractor will maintain the air voids, within the allowable working ranges by adjusting the gradation or asphalt content within the allowable working ranges. The target values of the control sieves provided by the mix design (JMF) will be the target values for the control limits. The target value for the bitumen will be the target value set by the JMF. The field test results may vary from the JMF target values as shown in Table B.

**TABLE B
ALLOWABLE WORKING RANGES**

Parameter	Single Test Control Limit	Moving Average Control Limit¹
Percent Lightweight Pieces of Aggr.	Not more than the maximum specified	
Percent Fractured Faces	Not less than the minimum specified	

Plastic Index	Not more than the maximum specified	
1/2" & #4 Sieve	± 6	± 5
#30 sieve	± 5	± 4
#200 Sieve ²	± 2.0	± 1.5
Asphalt Content	± 0.30	± 0.24
Air Voids (plugs)	2% to 6%	3% to 5%

¹ Average of last 4 tests

² Not to exceed the maximum specified.

2. **Corrective Action.** When a single-test control limit has been exceeded, the Contractor will immediately re-sample and retest. If the re-sample exceeds the control limits, corrective action will be instituted by the Contractor immediately. After the corrective action, the Contractor will immediately resample and retest. The corrective action will be documented.

Immediate shutdown will result when two consecutive tests exceed the single-test control limits for percent Lightweight pieces of aggregate, percent Fractured Faces, or Plastic Index. Operations will resume when the Engineer is satisfied that corrective action has been taken.

When the moving average values trend toward the moving-average control limits, the Contractor will take corrective action and increase the sampling and testing rate. The corrective action will be documented.

When the moving average of the control sieves or the bitumen exceeds the moving-average control limits, the Contractor may continue production if the air voids are within the control limits and the material passing the number 200 sieve does not exceed the maximum specified. The Contractor will take the necessary corrective action to produce mix based on the JMF or the Contractor may request that new target values be set if the production test results indicate adjustments to the target values are necessary. The Contractor may only make the changes requested with the approval of the Engineer.

When the moving average of the air voids exceeds the moving average control limit, the Contractor will immediately cease operations and take necessary corrective measures to get production back within the control limits. Quality control testing will resume as soon as the plant has started and operations are stabilized.

It will be the responsibility of the Contractor to shut down operations when the control limits are exceeded as specified. Failure to cease operations shall subject all material produced after exceeding the control limits to be considered unacceptable.

3. **Documentation.** The Contractor will maintain complete records of all process quality control tests and inspections. All test results and calculations will be recorded and documented on data sheets approved by the Department. Copies of the records will be furnished to the Engineer.

The Contractor will maintain standardized control charts at the field laboratory. Test results obtained by the Contractor will be recorded on the control chart immediately upon completion of the test. The following parameters will be recorded on the control chart:

- Gradation of the control sieves¹
- Asphalt Content
- Maximum Specific Gravity
- Bulk Specific Gravity
- Percent Air Voids of field marshall plugs
- Daily average Air Voids percentage of the cores
- Average Daily Density
- Calculated A.C. Film Thickness (Microns) (informational only)
- Calculated Dust/Effective A.C. Ratio (informational only)
- VMA (Informational only)
- Film Thickness (informational only)

¹ The control sieves are the 1/2 inch, #4, #30, and #200 sieves.

The control charts will display the single-test control limits for each test parameter, the individual test results, the moving average control limits, and the moving average of the last four tests. The moving average results and control limits, and the single tests and control limits will be color coded for easy distinction.

The control charts will be available at the field laboratory and will be accessible at all times for review by the Engineer.

- P. **Verification Testing.** The Engineer will conduct verification tests on independent samples. Cold feed belt, bitumen tank samples and coring shall be sampled by the Contractor under the observation of the Engineer. Sampling of the asphalt mix behind the paver will be conducted by the Engineer. The Engineer will test at an increased rate during the first lot of production to determine the accuracy of the quality control testing. Frequencies for verification testing are located in the Department's *Field Sampling and Testing Manual*. Test results performed by the Engineer will be available to the Contractor.

The Engineer will make random checks for Asphalt Content, as specified in Section 409.04 O.

Samples may be taken and tested by the Department any time the material appears defective or where the Engineer determines that a change in the process or production has occurred.

- Q. **Independent Assurance Testing.** The Contractor's quality control technician will test the aggregate and bituminous mix as specified and provide split samples to the Department for independent assurance testing. The Department will test the aggregate and bituminous mix at random times throughout the project at the fre-

quencies defined in the Department's *Field Sampling and Testing Manual*. Test results will correlate within the acceptable tolerances specified in Table C.

**TABLE C
ACCEPTABLE TOLERANCES FOR INDEPENDENT ASSURANCE**

5/8 inch - #4 Sieve	± 5%
#30 Sieve	± 3%
#200 Sieve	± 1.5%
Plastic Index	± 2%
Fractured Faces	± 5%
Air Voids	± 1.0%
Max. Sp. Gr.	± 0.020
Lightweight Pieces of Aggr.	± 1%
Bulk Specific Gravity (dry), each Aggr. Fraction ¹	± 0.040
Apparent Specific Gravity, each Aggr. Fraction ¹	± 0.040

¹ These items are not final mixture acceptance items.

409.05 ACCEPTANCE.

The aggregate gradation pay factor in Section 409.05 A.1 and the bitumen uniformity requirements in Section 409.05 B.2 will not apply when the total plan quantity of hot bituminous pavement is 4,000 tons or less. When the total plan quantity of hot bituminous pavement is 4,000 tons or less the material will be accepted according to Section 105.07.

A. Aggregate.

- 1. Gradation.** Aggregate will be sampled and tested in lot sizes equal to the number of tons produced. The aggregate gradation specified will be the basis of acceptance.

The Contractor shall obtain all aggregate samples at random times determined by the Engineer. The samples shall be taken from the cold feed belt according to AASHTO T 2, Section 4.3.1 or 4.3.2. The sample shall be split into two representative samples, numbered and bagged by the Contractor under the observation of the Engineer. The untested half of the sample will be retained by the Engineer for 24 hours after the test results are made known to the Contractor. Either party may request that the second half of the sample be tested within this 24-hour time frame. The test results from this retest shall replace the test values of the initial test.

One aggregate sample will be taken for each 1,500 ton of mix produced with a minimum of one sample per day. Payment for the mix represented by the samples will be based on the uniformity of the test results.

If any two consecutive tests vary from the JMF gradation target value set for each sieve by more than the tolerances listed below, the pay factor for the full days production will be the lowest pay factor determined from the following formula, unless the daily air voids of the marshall plugs as determined in Section 409.05 C.1 are between 3 and 5 percent and the aggregate gradation for

each sieve is not outside the gradation band for the class of aggregate specified, then the pay factor will be 100 percent.

$$\text{Pay Factor} = \frac{100 - \text{Deviation from the Target Range}^*}{100}$$

* Target Range = target value + or - the acceptable tolerance value

Acceptance of the aggregate will be based on the target values for the control sieves and the allowable working range for the single test control limit as shown in Section 409.04 O.1 Table B.

If the average daily air voids of the marshall plugs are not between 3 and 5 percent and the material fails to meet the specifications for two consecutive lots, the Contractor shall not incorporate any additional material into the work until the Engineer is satisfied that the Contractor is taking the necessary corrective action to meet the Specifications.

2. **Additional Aggregate Tests.** Aggregate samples to determine shale content, plasticity index, fractured faces, and L. A. Abrasion loss will be taken by the Contractor, under the observation of the Engineer, before the addition of bitumen to the mix.

The shale content and plasticity index of the aggregate will be determined by the average of test results from three random samples taken from the cold feed belt from each lot of 10,000 tons or fraction thereof. The samples will be tested and the material will be accepted if the average of the three samples meets the specified requirements. If each of the samples is within the specified limits, only one of the three samples will be tested from each subsequent lot. If at any time the sample tested does not meet the specified requirements, the remaining two samples will be tested. The average of these three samples will then be used to determine acceptance of the material. The testing of three samples per lot will continue until all three samples are within the specified limits, then only one of the three samples will be tested from each subsequent lot. If the average exceeds the specified maximum for shale content, the unit price for the bituminous mixture will be adjusted according to Section 409.07 B. If the average fails to meet the specified requirements for plasticity, the material will be rejected, unless the Engineer elects to accept it under Section 105.07.

The L. A. Abrasion loss percentage of aggregate will be determined on the basis of 1 composite aggregate sample taken and tested during the beginning of the aggregate stockpiling. If this percentage exceeds the maximum allowable loss, the material will not be accepted.

The percentage of fractured faces for coarse aggregates will be determined by the average of test results from three random samples taken from the cold feed belt for each lot of 10,000 tons of bituminous mixture produced. The samples will be tested and the material will be accepted if the average of the three samples meets the specified requirements. If each of the samples is within the specified limits, only one of the three samples will be tested from each subsequent lot. If at any time the sample tested does not meet the specified requirements, the remaining two samples will be tested. The average of

these three samples will then be used to determine acceptance of the material. The testing of three samples per lot will continue until all three samples are within the specified limits, then only one of the three samples will be tested from each subsequent lot. If the average fails to meet the specified requirements, the material will be rejected unless the Engineer elects to accept it under Section 105.07.

- B. **Bitumen Content.** The required bitumen content, or target percentage, will be designated by the Engineer.

The quantity of bitumen used and paid for from each lot will be determined by the use of daily oil cutoffs following the procedures outlined on the Mix Bitumen Cut-off Report. A lot shall be defined as the amount of bitumen used each production day.

The pay factor for the hot bituminous pavement, adjusted for bitumen content, will be the lowest pay factor determined by both of the following methods:

1. **Average.** If the daily cutoff, as determined on the Mix Bitumen Cutoff Report, deviates from the target percentage set by the Engineer by more than 0.24 percentage points the pay factor will be determined from the following table:

BITUMEN CONTENT

Pay Factor	Deviation from Target in Percentage Points
1.00	0.00-.24
0.98	0.25-.29
0.95	0.30-.34
0.92	0.35-.39
*	0.40 & Over

*The Engineer will determine the pay factor according to Section 105.07.

2. **Uniformity.** The Engineer will check the asphalt content each time an aggregate sample is taken. The checks will be based on readings from the totalizers for the aggregate and the bitumen as outlined in the Asphalt Content Determination Report. If the asphalt content from any random reading varies from the daily average of the readings by more than 0.24 percentage points, the pay factor for the hot bituminous material will be adjusted according to the following formula:

$$\text{Pay Factor} = \frac{100 - [20 (* \text{Deviation} - 0.24)]}{100}$$

*Deviation from the average daily asphalt content.

- C. **Compaction.**

1. **Testing.** The compaction of the mixture will be accepted in lot sizes equal to the number of tons placed each production day. The density of the pavement will be determined from cores obtained by the Contractor, as specified in Section 409.05 C.2.

Each subplot will be one paver width wide, excluding the shoulders, 2,000 feet long, and of the depth specified for the pavement course. If the partial subplot remaining at the end of a production day is 1,000 feet in length or longer, it will be considered a separate subplot. If it is less than 1,000 feet long, it will be included in the last complete subplot. If the total day's production is less than 2,000 feet long (one paver width wide), that production will be considered a lot.

The mean density of the mainline pavement placed each production day will be the average of the densities of all of that day's sublots. In addition to testing randomly selected locations, the Engineer reserves the right to direct the testing of any areas which appear defective. Defective areas will be rejected unless the Engineer elects to accept it under Section 105.07.

The Contractor, under the observation of the Engineer, shall:

- a. Obtain mix samples from behind the paver at random times specified by the Engineer. One sample shall be taken each time an aggregate sample is taken; and
- b. Compact three Marshall specimens with each sample taken to determine the field Marshall density. The number of blows applied to the Marshall specimens shall be 50, unless otherwise specified, and the temperature of the mix shall be 270 plus or minus 5°F.; and
- c. Determine the Maximum Theoretical Density of each sample taken.

The methods used to obtain the samples, compact the Marshall specimens and determine the Maximum Theoretical Density shall be as outlined in the Department's *Field Sampling and Testing Manual*.

2. **Contractor Coring.** The Contractor shall take one core in each subplot at a random location determined by the Engineer and under the observation of the Engineer. After coring and sawing, the cores shall be handed over to the Engineer. The cores shall be taken adjacent to each other and the average of the two cores shall be used for determining the density of the subplot.

The Contractor shall take one additional full-depth core per mile, under observation of the Engineer, for the District Materials Coordinator to use as an independent assurance test. The District Materials Coordinator will determine the locations of these cores. The cores shall be marked and delivered to the District Materials Laboratory. The cores shall not be sawed by the Contractor.

The coring machine shall cut a cylindrical sample in the compacted asphalt lift without disturbing the density of the sample. The core samples shall be 4 to 6 inches in diameter. The masonry saw shall cut the core sample so only the compacted layer to be tested is removed; and the core is in a condition suitable for testing.

Coring of each day's paving shall be completed no later than the next working day following the placement of the lift. Cores shall be taken through the full depth of the in-place asphalt pavement. The surface of the outside of the cores shall be smooth with no distortion of the cylindrical shape or displacement of

the aggregate particles. A masonry saw shall be used to remove the compacted layer from the full-depth core without damaging the newly placed asphalt material.

The Contractor shall fill all holes remaining in the surface of the roadway with bituminous material and compact the material as directed by the Engineer. Each core shall be numbered or lettered to identify the location from which the core was taken. The marking system shall meet the approval of the Engineer.

The Contractor may elect to take a check sample, at the Contractor's expense, whenever the average density of a set of cores is 89 percent or less than the Theoretical Maximum Density. A check sample shall be a set of cores taken within 2 feet of the location of the failing set of cores. The average density of the check sample cores will be the result used to determine the Unit Price of the hot bituminous pavement.

Retests and additional tests will not be taken or paid for unless approved by, or directed by, the Engineer.

The Contractor shall control traffic according to the traffic control plan to ensure the safety of the coring crew and the traveling public. The Engineer may alter these requirements depending on the location of the coring operation in respect to the existing traffic control zone, and in situations where traffic is being controlled by a pilot car and/or flaggers. Coring operations shall not take place adjacent to the paver to avoid blocking traffic.

3. **Compaction Payment Schedule.**

Acceptance of mainline pavement placed on any production day will be based on the average density of the pavement compared to the daily average maximum theoretical density (MTD) determined for each lot of pavement placed. The average density of the field cores shall be at least 91 percent of the daily average MTD. Each individual subplot shall have an average density of at least 89 percent of the daily average MTD. If the average density of the field cores is less than 91 percent of the daily average MTD or any subplot is less than 89 percent of the daily average MTD the Unit Price of the hot bituminous pavement will be adjusted according to the following tables:

PAVEMENT DENSITY ADJUSTMENT OF UNIT BID PRICE PER LOT

Pay Factor A	Average Pavement Density
1.00	91% or greater
0.99	90.0% - 90.9%
0.975	89.0% - 89.9%
0.95	88.0% - 88.9%
0.925	87.0% - 87.9%
*	Less than 87.0%

Pay Factor B	Lowest Density of any Sublot
1.00	89% or greater
0.99	88.0% - 88.9%
0.98	87.0% - 87.9%
0.97	86.0% - 86.9%
0.96	85.0% - 85.9%
*	Less than 85.0%

*The Engineer will determine whether the material may remain in place. The Pay Factor for the material allowed to remain in place shall be 0.70 for Pay Factor A and 0.80 for Pay Factor B.

The density of the field cores will be determined according to the Department's *Field Sampling and Testing Manual*. The Total Pay Factor will be the product of the pay factor for the average pavement density and the lowest subplot.

$$\text{TOTAL PAY FACTOR} = (\text{PAY FACTOR A}) \times (\text{PAY FACTOR B})$$

D. **General.**

The Contractor's Quality Control test results will be used for acceptance if they are within acceptable tolerances. A table for comparison of Verification Testing and Quality Control Testing is located in the Department's *Field Sampling and Testing Manual*.

The Contractor's Quality Control Program will be conducted by qualified personnel as outlined in the applicable Department Transportation Certification Program.

If the results of the Department's verification sampling and testing program do not agree with the QC sampling and testing as performed by the Contractor, the Department, or its Representative, will conduct a review of the quality control and verification procedures, calculations, and equipment to determine the cause of discrepancy.

E. **Dispute Resolution Program.**

If the cause of disagreement between the verification and quality control results cannot be determined, the dispute resolution process as outlined in the Department's *Field Sampling and Testing Manual* will be implemented.

409.06 METHOD OF MEASUREMENT.

The estimated quantities provided may be adjusted by the Engineer in the field. Any increase or decrease in the quantities used shall not be a basis for renegotiation in the price bid for these items.

- A. **Hot Bituminous Pavement.** Hot Bituminous Pavement will be measured by the Ton or Square Yard according to Section 109. Batch weights will not be permitted as a method of measurement unless the plant is equipped with an automatic batching and weighing system with an automatic printer system which prints the weights of each batch and issues a weigh ticket for each load. The tonnage will be

the weight used in the accepted pavement and no deduction will be made for the weight of bitumen used in the mixture.

- B. **Bitumen.** Bitumen will be measured according to Section 109 and the quantity of bitumen will be the number of Tons or Gallons used in the accepted work.
- C. **Cored Sample.** Each individual cored sample that is removed in the required condition will be measured as a unit. The work vehicle, coring machine, masonry saw, and shadow vehicle will not be measured for payment, but will be included in the measurement of the cored sample.
- D. **Testing.** All cost incurred for the Quality Control Testing, and contractor developed mix design when specified on the Plans, will not be measured separately and shall be included in the price bid for other items.

409.07 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Hot Bituminous Pavement QC/QA	Ton
Asphalt Cement	Ton or Gallon
Cored Sample	Each

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

When price adjustments are required for failing material or patching, payment will be made as follows:

- A. Determination of the payment adjustment of a lot of bituminous mixture will be made by successively multiplying the Contract Unit Price per Ton of the bid item by the applicable pay factors as determined in Sections 409.05 A, 409.05 B, and 409.05 C.
- B. When the average of the test results specified in Section 409.05 A.2 shows a larger shale content than the maximum allowable specified, the following deduction from the Bid Price for the bituminous mixture item will be made:

One percent reduction in unit price for each 0.2 percent above the maximum allowable percentage. If the percentage of shale exceeds the allowable limits by 2 percent or more, the material will be rejected unless the Engineer elects to accept it under Section 105.07.

This reduction will apply to lots of 10,000 tons, and will be applied independently of Section 409.05 A.1

- C. Material for patching or leveling of an existing bituminous surface constructed under a previous Contract shall be obtained from the tonnage provided in the basis of estimate and will be paid according to Section 408.07 C.

**SECTION 410
HOT BITUMINOUS PAVEMENT
SUPERPAVE VOLUMETRIC MIX DESIGN**

410.01 DESCRIPTION.

This work shall consist of constructing one or more courses of bituminous pavement on a prepared surface for Quality Control/Quality Assurance (QC/QA) projects. The Contractor shall be responsible for process control, and shall perform the necessary testing to control the quality of the work. When specified on the plans the contractor shall develop a mix design.

410.02 MATERIALS.

- A. **Bitumen.** The bitumen shall meet Section 818 and will be of the type and grade specified in the Contract. Bitumen will be accepted as outlined in the Combined State Binder Group agreement for North Dakota. Samples will be obtained by the Contractor under the observation of the Engineer, and immediately handed over to the Engineer for shipping and testing.
- B. **Aggregate.** The aggregate blend gradation will initially be based on the specifications in Table 1 and finally determined by the mix design compaction and volumetric results. A tolerance of 2 percent in the amount passing the 5/8-inch sieve will be permitted providing all material passes the 3/4-inch sieve.

**TABLE 1
INITIAL CONTROL POINTS FOR SUPERPAVE AGGREGATE
BLEND GRADATION**

Sieve Size	Nominal Aggregate Size* 1/2" (12.5 mm) Percent Passing	
	Min.	Max.
5/8" (15.9 mm)	100	100
1/2" (12.5 mm)	90	100
#8 (2.36 mm)	28	58
#200 (75 μ)	2.0	7.0

*Nominal aggregate size is defined as 1 sieve size larger than the first sieve to retain more than 10 percent.

The Superpave aggregate shall meet the requirements of Table 2.

**TABLE 2
AGGREGATE TESTING CRITERIA**

Test	Criteria	Reference/Comments
Coarse Aggregate Angularity, %	As specified on Plans	NDDOT <i>Field Sampling and Testing Manual</i> , the requirement is for 1 fractured face
Fine Aggregate Angularity, %	As specified on Plans	AASHTO T 304, the criteria are % air voids in loosely compacted fine aggregate
Clay Content % Sand Equivalent	40 minimum	AASHTO T 176
Flat & Elongated Particles, %	10 maximum	ASTM D 4791
Toughness, % Loss	40 maximum	AASHTO T 96
Lightweight Pieces in Aggregate, % Shale	5 maximum	AASHTO T 113, NDDOT Modified
Deleterious Materials % Spall	1.0 maximum	AASHTO T 112, "Clay Lumps and Friable Particles in Aggregate"

410.03 EQUIPMENT.

Equipment shall be as specified in Section 408.03.

410.04 CONSTRUCTION REQUIREMENTS.

GENERAL

Contractor Quality Control. Quality Control (QC) will be the responsibility of the Contractor. The Contractor will perform quality control sampling, testing, and inspection during all phases of the work at a rate sufficient to assure that the work conforms to the Contract requirements. The Contractor shall have at least one person on the project, at all times who is certified as an asphalt mix controller and one person certified as an aggregate lab and asphalt mix tester. The inspector shall be certified as an Asphalt Pavement Inspector. Certification requirements will be as outlined in the Department's Transportation Certification Program (TCP). If the Prime Contractor sublets any portion of the Contract, including aggregate production, to a Subcontractor, the Subcontractor shall have a person certified as an asphalt mix controller on the project. If the Subcontractor does not have a certified person, the Prime Contractor's certified person shall be on the Project and be in charge of quality control.

Quality Control Plan. Prior to beginning work the Contractor will submit a "Quality Control Plan" to the Engineer. The Plan will contain: 1) the names and phone numbers of the individual(s) responsible for the Contractor's quality control program; 2) a listing of the technician(s) responsible for the quality control testing; 3) an organizational chart indicating lines of authority (including names and phone numbers); 4) a summary of the qualifications of the Quality Control Technicians, and 5) Details of the contractor's quality control plan addressing but not limited to the following items: 1) pit op-

erations and methods used to control uniformity, reducing segregation, and efficiently utilizing the aggregate resources of the pit; 2) plant operations discussing proposed equipment (number of bins, plant type, etc.) and method of operations; 3) testing frequency and how this meets the intent of the Special Provision; and 4) discussion of how the Contractor's quality control program will respond to the need for corrective action as defined in Section 410.04 Q.

The Department will provide the Contractor with: 1) the names and phone numbers of the individual(s) responsible for project administration; 2) a listing of the technician(s) responsible for the quality assurance testing; and 3) an organizational chart indicating lines of authority (including names and phone numbers).

Quality Control Laboratory. The Contractor will provide a materials tester certified as an aggregate lab and asphalt mix tester to perform all testing including all testing during aggregate production. The Contractor shall also provide testing equipment that meets the requirements for all tests called for by Specification. This laboratory will be measured and paid according to Section 706.

The Contractor will furnish and maintain a Type C laboratory at the plant as specified in Section 706 of the Standard Specifications. Any other laboratory location must be approved by the Engineer. The laboratory will be furnished with the necessary equipment and supplies for performing the Contractor's QC testing and mix design if specified on the plans, including a Superpave Gyratory Compactor meeting all FHWA and AASHTO T 312 requirements. During production of the aggregate, the Contractor may furnish a lab equipped with the necessary equipment to perform the following aggregate tests: bulk and apparent specific gravity, gradation analysis, lightweight pieces of aggregate, plastic index, and fractured faces. The Type C laboratory must be set up and ready to use before the paving operation begins.

Engineer's Laboratory. The Contractor will provide an additional Type C laboratory to be used during actual mix production by the Department's aggregate lab and asphalt mix tester. The testing equipment will be provided by the Department. The lab will be set up at the plant prior to production of the bituminous mix and be made available to the Engineer for Quality Assurance testing. The Contractor and the Engineer will share the Gyratory Compactor provided for the Contractor's lab. This laboratory will be measured and paid according to Section 706.

A. Pit Operations and Stockpiling of Aggregate. During production of the aggregate, the aggregate will be tested for gradation, fine aggregate angularity, lightweight pieces of aggregate, flat and elongated pieces, coarse aggregate angularity and clay content. The testing frequency for gradation will be one test per 1,000 tons of material produced for each aggregate stockpile. The testing frequency for lightweight pieces of aggregate, flat and elongated pieces and coarse aggregate angularity will be the average of three random composite samples from the first 5,000 tons of material produced. The testing frequency for the fine aggregate angularity and clay content will be the average of three random samples from the first 5,000 tons of material produced from each stockpile. The fine aggregate angularity and clay content from each stockpile will be combined to determine the final blend results. If all three samples pass, the testing frequency will change to one of three samples tested for each 10,000 tons of material produced. If a sample fails, the remaining two samples will be tested and averaged for acceptance of that lot. The testing frequency will then revert to the average of three tests per 5,000 tons until all three samples pass, then one of three samples will be tested for each 10,000 tons.

During the first week of aggregate production, for each class of aggregate, as soon as the Contractor determines the aggregate is representative, and prior to the initial mix design, the Contractor shall obtain a 90-pound sample of each aggregate component. The Contractor shall split the samples under the observation of the Engineer. One-half of each aggregate sample will be submitted to the Engineer for testing. The Contractor and the Engineer will test the samples to determine the bulk (dry) and apparent specific gravity and the percent water absorption by dry weight of aggregate. The testing will be completed according to AASHTO T 84, T 85 and the procedures in the Department's *Field Sampling and Testing Manual*. One test will be performed for each 10,000 ton of each aggregate component produced. A minimum of two tests will be required for each aggregate component. Testing shall commence within two working days of sampling. Test results will be reported to each party as soon as they are available. If the individual specific gravity values determined by the Contractor and the Department correlate within 0.040, the average of the Contractor's numbers will be used to calculate the absorption, fines to asphalt ratio, and voids in mineral aggregate (VMA). If the individual specific gravity values determined by the Contractor and the Department do not correlate within the allowable tolerance (0.040), or if the Contractor fails to supply an aggregate that meets the mix design criteria then:

- The mix design will not be approved and mix production will be begin.
 - The Contractor has the option of running the test together with Department personnel at the District Lab and use those results, or testing differences can be resolved according to the procedures in the Department's *Field Sampling and Testing Manual*.
1. **Department-Developed Mix Design.** The Department will develop the mix design unless the plans specify that the Contractor shall develop the mix design.
 - a. After 10,000 tons of material is produced, the Contractor will provide the Department with an aggregate sample representing each stockpile and asphalt required for the mix design. The Contractor shall develop a preliminary gyratory mix design and submit the results to the Department. This mix design is for informational purposes to assure the Contractor has produced specified material. The Department will develop the mix design for the project. The Contractor shall provide all of the information required for the JMF, except Standard R30, Mix Conditioning of Hot Mix Asphalt (HMA).
 - b. When the Department's mix design is approved and testing indicates uniform results for fine aggregate angularity, flat/elongated pieces or course aggregate angularity, and both parties are confident that future production will remain within the specifications, the Engineer, by written notice, may reduce the frequency of the tests.
 2. **Contractor Developed Mix Design.** The Plans will specify when the contractor shall develop the mix design.
 - a. After production of 5,000 tons and before production of 10,000 tons of aggregate, the Contractor shall develop a preliminary Superpave mix design and submit the results to the Department. This preliminary mix de-

sign is for informational purposes to assure the Contractor has produced specified material. The Contractor shall provide all of the information required for the JMF, except Standard R30, Mix Conditioning of Hot Mix Asphalt (HMA).

- b. After 10,000 ton of material is produced the Contractor shall develop the mix design for the project.
- c. When the Contractor's mix design is approved by the Engineer and testing indicates uniform results for fine aggregate angularity, flat/elongated pieces or coarse aggregate angularity, and both parties are confident that future production will remain within the specifications, the Engineer, by written notice, may reduce the frequency of the tests.

The Contractor will sample and test the aggregate according to the procedures of the Department's *Field Sampling and Testing Manual*.

The Contractor will provide the Engineer with copies of the test results for each stockpile of aggregate that will be incorporated into the mix by noon of the following day the tests are completed. The test reports will include results for gradation, fine aggregate angularity, lightweight pieces of aggregate, flat and elongated pieces, coarse aggregate angularity, clay content and the bulk and apparent specific gravity.

If the mix design meets the properties specified and Department and the Contractor mutually agree it is necessary to adjust the aggregate production operation to produce an aggregate that will improve the mix design properties, the Department will negotiate an equitable adjustment with the Contractor to produce an aggregate that meets the desired mix design properties.

- B. Volumetric Mix Design.** The mix design used will be a lab mix design developed by the Department or developed by the Contractor, when specified on the Plans, and approved by the Department. The mix design procedures shall be performed according to the AASHTO Standards outlined in Table 3.

When the Department develops the mix design the Contractor will provide a minimum of 165 pounds (75 kg) of each stockpile and ten 1-liter cans of the PG binder, AC specific gravity, and supplier to be used on the project at least 30 days prior to production. A sample tag identifying the project number and pit location shall be attached to each sample. The Department will then have two weeks to return a Job Mix Formula (JMF) to the Contractor.

When making the blend determinations for the mix design, the value used for each sieve, from each stockpile, shall be the average of the production samples.

The mix design process will consist of two separate mix design procedures. The first will be a Trial Mix Design, the second will be the Final Mix Design. The Trial

Mix Design will determine the aggregate blend to be used in the Final Mix Design.

TABLE 3
AASHTO SUPERPAVE MIX DESIGN STANDARDS

AASHTO Designation	Title
T312	Method for Preparing and Determining the Density of Hot Mix Asphalt Specimens by Means of the SHRP Gyratory Compactor
R 35	Practice for Superpave Volumetric Design for Hot Mix Asphalt
R 30	Mix Conditioning of Hot Mix Asphalt (HMA)
M 323	Specification for Superpave Volumetric Mix Design
T166	Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens

1. **Trial Mix Design/Aggregate Blend Determination.** The Trial Mix Design shall consist of a minimum of 3 different aggregate blends mixed with a minimum AC content determined by Equation 1. The aggregate shall be blended so that at least 1 is a coarse type blend, a second is an intermediate type blend and a third is a fine type blend. The 0.45 power chart will be used to determine the blend type. Two plugs shall be compacted for each aggregate blend.

The number of gyrations used for compaction shall be specified on the Plans. A compaction and volumetric analysis will then be done to determine the estimated blend properties at 4.0 percent air voids. Each individual blend property will then be compared to the criteria outlined in Table 4. The blend which best fits the criteria will be used for the Final Mix Design. If no blend satisfactorily meets the criteria, one or more new blends will be proportioned and the Trial Mix Design repeated. If the second Trial Mix Design fails to produce a satisfactory aggregate blend then the aggregate production process will be reviewed.

Equation 1

$$\% \text{ Design AC by Weight of Mix} = [(VMA - AV) * (G_b) / (G_{mb})] + \%AC \text{ abs}_{est}$$

Where:

- VMA = Desired mix voids in mineral aggregate
- AV = Desired mix air voids
- G_b = Specific gravity of the asphalt binder
- G_{mb} = Desired bulk spec. gravity of the mix
- %AC abs_{est} = Estimated AC Absorption = 0.5* water absorption

**TABLE 4
HMA TESTING CRITERIA**

Procedure/Property/Test	Criteria	Reference
Gyratory Compaction Effort, # Gyration	As specified on Plans	AASHTO R 35
Voids in Mineral Aggregate, % Minimum	14.0 for 1/2" Nominal Maximum Aggregate ¹	AASHTO M 323 AASHTO T 166
Voids Filled with Asphalt, %	As specified on Plans	AASHTO M 323 AASHTO T 166
% G_{mm} @ N_{ini} ² (Desired)	As specified on Plans	AASHTO M 323 AASHTO T 166
% G_{mm} @ N_{max} ²	98.0 Maximum	AASHTO M 323 AASHTO T 166
Dust/Effective Asphalt Ratio	0.6 - 1.3 (Top Lift) 0.6 - 1.4 (Bottom Lift)	AASHTO M 323 AASHTO T 166
Desired Moisture Sensitivity, Min. % Strength Retention ²	70 @ 7.0 ± 1% Air Voids	AASHTO T 283 AASHTO R 30
Asphalt Film Thickness ² (Microns)	7.5 - 13	See Below

¹Nominal maximum aggregate size is defined as one sieve size larger than the first sieve size to retain more than 10 percent of the aggregate.

²Desired value, final determination to be made by Materials and Research Engineer.

Determination of Surface Area

Sieve Analysis % Passing								
Sieve	Max. Size	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200
Combined Grading	***	***	***	***	***	***	***	***
Coefficient	0.02	0.02	0.04	0.08	0.14	0.30	0.60	1.60

*
$$\text{Film Thickness FT} = \frac{(Pbe)(4885)}{(100)(SA)}$$

Where: Pb = asphalt cement, percent, mixture basis
Pba = percent AC absorbed by weight of aggregate
Ps = aggregate, percent mixture basis
Pbe = effective asphalt content, percent, mixture basis
FT = film thickness (Microns)
SA = surface area (ft²/lb)

** The Dust/Effective asphalt ratio shall be determined by dividing the percentage of material passing the #200 sieve by the percentage of effective asphalt added to the mix. The percentage of asphalt used will be as determined in the Mix Design at 4 percent air voids.

The effective asphalt will be determined as follows: (The formula is as defined in Manual Series No. 2 published by the Asphalt Institute.)

$$P_{be} = P_b - \frac{(P_{ba})(P_s)}{100}$$

*** The gradation used for calculating film thickness and dust/effective A.C. ratio will be the combined gradation results of the actual material used to run the mix design. Perform calculations to the nearest hundredth and round to the nearest tenth.

2. **Final Mix Design/Job Mix Formula Determination.** After the Trial Mix Design is done, the Final Mix Design is conducted. The aggregate blend used shall be the blend determined to best fit Superpave criteria from the Trial Mix Design. Five AC contents will be used in the Final Mix Design. The AC contents used shall be:
 - a. The optimum AC content determined by the Trial Mix Design.
 - b. 0.5 percent below the optimum AC content determined by the Trial Mix Design.
 - c. 0.5 percent above the optimum AC content determined by the Trial Mix Design.
 - d. 1.0 percent below the optimum AC content determined by the Trial Mix Design.
 - e. 1.0 percent above the optimum AC content determined by the Trial Mix Design.

A minimum of two specimens shall be compacted for each AC content. The same criteria for compaction and volumetric evaluation referenced for the Trial Mix Design are used.

Once the mix is evaluated, graphs representing Air Voids, VMA and VFA versus percent AC binder are plotted. The design AC content is then selected for 4.0 percent air voids. The mix characteristics at the selected design AC content are then compared to the criteria for Fine Aggregate Angularity, Flat and Elongated Pieces, Clay Content, VMA, VFA, percent $G_{mm} @ N_{ini}$, percent $G_{mm} @ N_{max}$, and Dust/Asphalt Ratio outlined in Tables 3 and 5. If the results meet the mix design criteria this mix then becomes the JMF.

If the results from the Final Mix Design do not meet the mix design criteria then one of the two following options will be selected:

- a. The Final Mix Design will be redone.
 - b. Start over with the Trial Mix Design.
3. **Moisture Sensitivity Test.** Once a JMF is determined a moisture sensitivity test will be conducted on the mix according to AASHTO T 283, "Resistance of Compacted Bituminous Mixture to Moisture Induced Damage". The Marshall specimens shall be compacted to 7.0 percent \pm 1.0 percent air voids. The tensile strength ratio shall be a minimum of 70 percent.
 4. **Aggregate/Asphalt Supplied Other Than That Used in the Mix Design.** If aggregate or asphalt is utilized from sources other than those initially sub-

mitted, the aggregate is processed using a different crusher, or if a different type or grade of asphalt is used, the Contractor shall notify the Engineer in writing 12 working days prior to incorporating the material into the work. If the Engineer determines that a new mix design is required, the Contractor shall provide a sample of the material to the Engineer and allow the Department ten working days to prepare a new mix design. If the Contractor fails to provide a timely sample, the Contractor shall cease operations and allow the Department ten working days to prepare a new mix design.

NOTE: Sections C through N are as specified in the respective sections of 408.04, except the mix and compaction temperatures shall be according to the PG binder manufacturers' recommendation.

- O. **Quality Control Testing.** During production of the bituminous mix, the Contractor will be required to perform random sampling and testing on the aggregate and bituminous mix as the mix is being produced and placed on the roadway. Copies of all test results will be furnished to the Engineer by noon the following day.

The Contractor will sample and test the bituminous mix as outlined in the Department's *Field Sampling and Testing Manual*.

The Contractor will sample the aggregate from the cold feed and test the aggregate according to the Department's *Field Sampling and Testing Manual*. The tests will be performed at random times determined by the Engineer and at the frequency specified in Table 5.

**TABLE 5
QUALITY CONTROL TESTING FREQUENCIES**

Test	Frequency
Gradation (use all sieves for Cl. specified)	1/1500 tons
Lightweight Pieces of Aggregate ¹	3/10,000 tons
Fractured Faces ¹	3/10,000 tons
Maximum Sp. Gr. of Bit. Mix (Rice Method)	1/1500 tons
Bulk Sp. Gr. of Bit. Mix (Plugs) & Air Voids	1/1500 tons
Percent Asphalt Cement	1/1500 tons ²
Fine Aggregate Angularity	3/10,000 tons
Flat and Elongated Pieces ¹	3/10,000 tons
Clay Content	3/10,000 tons
Percent Density of Bit. Mix (Cores) ³	

¹The content of the lightweight pieces of aggregate, flat and elongated pieces and fractured faces of the aggregate will be determined by the average of test results from three random samples taken from the cold feed belt for each lot of 10,000 tons or fraction thereof. If all samples pass, only one of the three samples taken will be tested until a sample fails; then the remaining two samples will be tested and averaged for the acceptance of that lot. The testing of three samples per lot will continue until all three samples pass, then one of the three samples will be tested from each lot.

²The Contractor will make random checks of the asphalt content each time a gradation test is taken under the observation of the Engineer. The random checks will be based on readings from the totalizers for the aggregate and the bitumen as outlined in the Department's Asphalt Content Determination Report.

³The number of tests per lot will be as defined in Section 410.05 C. Compaction.

The Contractor will split and identify all samples. The split samples will be retained by the Contractor for testing by the Engineer. The samples to be tested by

the Contractor and given to the Engineer will be large enough to be split again, such that four samples are available for testing. The split samples of aggregate will be stored in a dry, protected location until picked up by the Engineer. The mix samples taken to determine the maximum specific gravity will be split after the sample has been allowed to cool prior to being placed in the flasks.

When quality control samples indicate uniform results on clay content or lightweight pieces of aggregate; and both parties are confident that future production will remain within the Specifications, the Engineer, by written notice, may reduce the frequency of the tests.

1. **Documentation.** The Contractor will maintain complete records of all process quality control tests and inspections. All test results and calculations will be recorded and documented on data sheets approved by the Department. Copies of the records will be furnished to the Engineer.

The Contractor will maintain standardized control charts at the field laboratory. Test results obtained by the Contractor will be recorded on the control charts immediately upon completion of the test. The following parameters will be recorded on the control charts:

- Gradation of the control sieves*
- Asphalt Content
- Maximum Specific Gravity
- Bulk Specific Gravity
- Percent Air Voids of field Gyratory plugs
- Daily average Air Voids percentage of the cores
- Average Daily Density
- Fines / Asphalt Ratio (informational only)
- Asphalt Film Thickness (microns) (informational only)

* The control sieves are the 1/2", #4, #30, and #200 sieves.

The control charts will display the single-test control limits for each test parameter, the individual test results, the moving average control limits, and the moving average of the last four tests. The moving average results and control limits, and the single tests and control limits will be color coded for easy distinction.

The control charts will be available at the field laboratory and will be accessible at all times for review by the Engineer.

2. **Control Limits.** The Contractor will maintain the air voids within the allowable working ranges by adjusting the gradation or asphalt content within the allowable working ranges. The target values for the control sieves and the bitumen will be the target values set for the JMF. The field test results may vary from the JMF target values as shown in Table 6.

**TABLE 6
ALLOWABLE WORKING RANGES**

Parameter	Single Test Control Limit	Moving Average Control Limit ¹
Percent Lightweight Pieces of Aggr.	Not more than the maximum specified	
Percent Fractured Faces	Not less than the minimum specified	

Fine Aggregate Angularity	Not less than the minimum specified	
Flat and Elongated Pieces	Not more than the maximum specified	
Sand Equivalent Test	Not less than the minimum specified	
1/2" and #4 Sieve	± 6	± 5
#30 sieve	± 5	± 4
#200 Sieve ²	± 2.0	± 1.5
Asphalt Content	± 0.30	± 0.24
Air Voids (plugs)	2% to 6%	2.5% to 5%

¹ Average of last four tests

² Not to exceed the maximum specified.

3. **Corrective Action.** When a single-test control limit has been exceeded, the Contractor will immediately re-sample and retest. If the re-sample exceeds the control limits, corrective action will be instituted by the Contractor immediately. After the corrective action, the Contractor will immediately re-sample and retest. The corrective action will be documented.

Immediate shutdown will result when two consecutive tests exceed the single-test control limits for percent Lightweight Pieces of Aggregate, Fine Aggregate Angularity, Coarse Aggregate Angularity, or clay content. Operations will resume when the Engineer is satisfied that corrective action has been taken.

When the moving average values trend toward the moving-average control limits, the Contractor will take corrective action and increase the sampling and testing rate. The corrective action will be documented.

When the moving average of the control sieves or the bitumen exceeds the moving-average control limits, the Contractor may continue production if the air voids are within the control limits and the material passing the number 200 sieve does not exceed the maximum specified. The Contractor will take the necessary corrective action to produce mix based on the JMF or the Contractor may request that new target values be set if the test results indicate that adjustments to the target values are necessary. The Contractor may only make the changes requested with the approval of the Engineer.

When the moving average of the air voids exceeds the moving-average control limit, the Contractor will immediately cease operations unless the Engineer is satisfied that the Contractor is taking corrective action. Quality control testing will resume as soon as the plant has started and operations are equalized.

It will be the responsibility of the Contractor to shut down operations when the control limits are exceeded as specified. Failure to cease operations shall subject all material produced after exceeding the control limits to be considered unacceptable.

- P. **Verification Testing.** The Engineer will conduct verification tests on independent samples. Cold feed belt, bitumen samples, sampling behind paver, and coring will be sampled by the Contractor under the observation of the Engineer. The Engineer will test at an increased rate during the first lot of production to determine the accuracy of the quality control testing. Frequencies for verification testing are located in the Department's *Field Sampling and Testing Manual*. Test results performed by the Engineer will be available to the Contractor.

The Engineer will observe the Contractor make the random checks for Asphalt Content as specified in Section 410.05.

Samples may be taken and tested by the Department any time the material appears defective or where the Engineer determines that a change in the process or production has occurred.

- Q. **Independent Assurance.** The Contractor's quality control technician will test the aggregate and bituminous mix, as specified, and provide split samples to the Department for independent assurance testing. The Department will test the aggregate and bituminous mix at random times throughout the project at the frequencies defined in the Department's *Field Sampling and Testing Manual*. These tests will assure equipment is operating properly and the sampling and testing is performed accurately. Independent Assurance tests for coarse aggregate angularity, fine aggregate angularity, flat and elongated pieces, and clay content shall be done during aggregate production at the frequency outlined in Appendix G of the Department's *Field Sampling and Testing Manual*. Test results will correlate within the acceptable tolerance, as specified in Table 7.

**TABLE 7
ACCEPTABLE TOLERANCES FOR COMPARISON OF
CORRELATION TEST RESULTS**

5/8" - #4 Sieve	± 5%
#30 Sieve	± 3%
#200 Sieve	± 1.5%
Fractured Faces	± 5%
Air Voids	± 1.0%
Maximum Specific Gravity (Sp. Gr.)	± 0.020
Lightweight Pieces of Aggregate	± 1%
Bulk Specific Gravity (dry), each Aggr. Fraction*	± 0.040
Apparent Specific Gravity, each Aggr. Fraction*	± 0.040
Fine Aggregate Angularity	± 2.5%
Flat & Elongated Pieces	± 2.5%
Clay Content	± 5.0%

*These items are not final mixture acceptance items.

- R. **Hot Mix Asphalt Sampling.** An additional 22 pounds of mix will be taken from behind the paver to accommodate the Superpave Gyratory Compactor (SGC) specimens.

410.05 ACCEPTANCE.

The aggregate gradation pay factor in Section 410.05 A.1 and the bitumen uniformity requirements in Section 410.05 B.2 will not apply when the total plan quantity of hot bituminous pavement is 4,000 tons or less. When the total plan quantity of hot bituminous pavement is 4,000 tons or less the material will be accepted according to Section 105.07.

- A. **Aggregate.**

1. **Gradation.** Aggregate will be sampled and tested in lot sizes equal to the number of tons placed each production day. The aggregate gradation specified will be the basis of acceptance.

The Contractor shall obtain all aggregate samples at random times determined by and under the observation of the Engineer. The samples shall be taken from the cold feed belt according to AASHTO T 2, Section 4.3.1 or 4.3.2. The sample shall be split into two representative samples, numbered and bagged by the Contractor under the observation of the Engineer. Both halves of the sample shall be submitted to the Engineer. The untested half of the sample will be retained by the Engineer for 24 hours after the test results are made known to the Contractor. Either party may request that the second half of the sample be tested within this 24-hour time frame. The test results from this retest shall replace the test values of the initial test.

One aggregate sample will be taken for each 1,500 ton of mix produced with a minimum of one sample per day. Payment for the mix represented by the samples will be based on the uniformity of the test results.

If any two consecutive tests vary from the JMF gradation target value set for each sieve by more than the tolerances listed below, the pay factor for the full days production will be the lowest pay factor determined from the following formula:

$$\text{Pay Factor} = \frac{100 - \text{Deviation from the Target Range}^*}{100}$$

*Target Range = target value + or - the acceptable tolerance value

Acceptance of the aggregate will be based on the target values for the control sieves and the allowable working range for the single test control limit as shown in Section 410.04 O Table 6.

If the average daily air voids of the gyratory specimens are not between 2 percent and 5 percent and the material fails to meet the specifications for two consecutive lots, the Contractor shall not incorporate any additional material into the work until the Engineer is satisfied that the Contractor is taking the necessary corrective action to meet the Specifications. The Engineer may request that a new mix design be developed if the Contractor is unable to meet the Specifications.

2. **Additional Aggregate Tests.** Aggregate samples to determine shale content, plasticity index, fractured faces, and L. A. Abrasion loss will be taken by the Contractor, under the observation of the Engineer, before the addition of bitumen to the mix.

The shale content and plasticity index of the aggregate will be determined by the average of test results from three random samples taken from the cold feed belt from each lot of 10,000 tons or fraction thereof. The samples will be tested and the material will be accepted if the average of the three samples meets the specified requirements. If each of the samples is within the specified limits, only one of the three samples will be tested from each subsequent lot. If at any time the sample tested does not meet the specified requirements,

the remaining two samples will be tested. The average of these three samples will then be used to determine acceptance of the material. The testing of three samples per lot will continue until all three samples are within the specified limits, then only one of the three samples will be tested from each subsequent lot. If the average exceeds the specified maximum for shale content, the unit price for the bituminous mixture will be adjusted according to Section 410.07 B. If the average fails to meet the specified requirements for plasticity, the material will be rejected, unless the Engineer elects to accept it under Section 105.07.

The L. A. Abrasion loss percentage of aggregate will be determined on the basis of one composite aggregate sample taken and tested during the beginning of the aggregate stockpiling. If this percentage exceeds the maximum allowable loss, the material will not be accepted.

The percentage of fractured faces for coarse aggregates will be determined by the average of test results from three random samples taken from the cold feed belt for each lot of 10,000 tons of bituminous mixture produced. The samples will be tested and the material will be accepted if the average of the three samples meets the specified requirements. If each of the samples is within the specified limits, only one of the three samples will be tested from each subsequent lot. If at any time the sample tested does not meet the specified requirements, the remaining two samples will be tested. The average of these three samples will then be used to determine acceptance of the material. The testing of three samples per lot will continue until all three samples are within the specified limits, then only one of the three samples will be tested from each subsequent lot. If the average fails to meet the specified requirements, the material will be rejected unless the Engineer elects to accept it under Section 105.07.

- B. **Bitumen Content.** The required bitumen content, or target percentage, will be designated by the Engineer.

The quantity of bitumen used and paid for from each lot will be determined by the use of daily oil cutoffs following the procedures outlined on the Mix Bitumen Cutoff Report. A lot shall be defined as the amount of bitumen used each production day.

The pay factor for the hot bituminous pavement, adjusted for bitumen content, will be the lowest pay factor determined by both of the following methods:

1. **Average.** If the daily cutoff, as determined on the Mix Bitumen Cutoff Report, deviates from the target percentage set by the Engineer by more than 0.24 percentage points the pay factor will be determined from the following table:

BITUMEN CONTENT

Pay Factor	Deviation from Target in Percentage Points
1.00	0.00-.24
0.98	0.25-.29
0.95	0.30-.34
0.92	0.35-.39
*	0.40 & Over

*The Engineer will determine the pay factor according to Section 105.07.

2. **Uniformity.** The Engineer will check the asphalt content each time an aggregate sample is taken. The checks will be based on readings from the totalizers for the aggregate and the bitumen as outlined in the Asphalt Content Determination Report. If the asphalt content from any random reading varies from the daily average of the readings by more than 0.24 percentage points, the pay factor for the hot bituminous material will be adjusted according to the following formula:

$$\text{Pay Factor} = \frac{100 - [20 (* \text{Deviation} - 0.24)]}{100}$$

*Deviation from the average daily asphalt content.

C. Compaction.

1. **Testing.** The compaction of the mixture will be accepted in lot sizes equal to the number of tons placed each production day. The density of the pavement will be determined from cores obtained by the Contractor, as specified in Section 410.05 C.2.

Each subplot will be one paver width wide, excluding the shoulders, 2,000 feet long, and of the depth specified for the pavement course. If the partial subplot remaining at the end of a production day is 1,000 feet in length or longer, it will be considered a separate subplot. If it is less than 1,000 feet long, it will be included in the last complete subplot. If the total day's production is less than 2,000 feet long (one paver width wide), that production will be considered a lot.

The mean density of the mainline pavement placed each production day will be the average of the densities of all of that day's sublots. In addition to testing randomly selected locations, the Engineer reserves the right to direct the testing of any areas which appear defective. Defective areas will be rejected unless the Engineer elects to accept it under Section 105.07.

The Contractor, under the observation of the Engineer, shall:

- a. Obtain mix samples from behind the paver at random times specified by the Engineer. One sample shall be taken each time an aggregate sample is taken; and
- b. Compact two gyratory specimens with each sample taken to determine the field gyratory density. The number of gyrations applied to the gyra-

tory specimens shall be as specified in the Plans or as specified by the Engineer, and the temperature of the mix shall be 270°F plus or minus 5°F; and

- c. Determine the Maximum Theoretical Density of each sample taken.

The methods used to obtain the samples, compact the gyratory specimens and determine the Maximum Theoretical Density shall be as outlined in the Department's *Field Sampling and Testing Manual*.

2. **Contractor Coring.** The Contractor shall take one core in each subplot at a random location determined by the Engineer and under the observation of the Engineer. After coring and sawing, the cores shall be handed over to the Engineer. The cores shall be taken adjacent to each other and the average of the two cores shall be used for determining the density of the subplot.

The Contractor shall take one additional full-depth core per mile, under observation of the Engineer, for the District Materials Coordinator to use as an independent assurance test. The District Materials Coordinator will determine the locations of these cores. The cores shall be marked and delivered to the District Materials Laboratory. The cores shall not be sawed by the Contractor.

The coring machine shall cut a cylindrical sample in the compacted asphalt lift without disturbing the density of the sample. The core samples shall be 4 to 6 inches in diameter. The masonry saw shall cut the core sample so only the compacted layer to be tested is removed; and the core is in a condition suitable for testing.

Coring of each day's paving shall be completed no later than the next working day following the placement of the lift. Cores shall be taken through the full depth of the in-place asphalt pavement. The surface of the outside of the cores shall be smooth with no distortion of the cylindrical shape or displacement of the aggregate particles. A masonry saw shall be used to remove the compacted layer from the full-depth core without damaging the newly placed asphalt material.

The Contractor shall fill all holes remaining in the surface of the roadway with bituminous material and compact the material as directed by the Engineer. Each core shall be numbered or lettered to identify the location from which the core was taken. The marking system shall meet the approval of the Engineer.

The Contractor may elect to take a check sample, at the Contractor's expense, whenever the average density of a subplot is 89 percent or less than the Theoretical Maximum Density. A check sample shall be a set of cores taken within two feet of the location of the failing set of cores. The average density of the check sample cores will be the result used to determine the Unit Price of the hot bituminous pavement.

Retests and additional tests will not be taken or paid for unless approved by, or directed by, the Engineer.

The Contractor shall control traffic according to the traffic control plan to ensure the safety of the coring crew and the traveling public. The Engineer may

alter these requirements depending on the location of the coring operation in respect to the existing traffic control zone, and in situations where traffic is being controlled by a pilot car and/or flaggers. Coring operations shall not take place adjacent to the paver to avoid blocking traffic.

3. **Compaction Payment Schedule.**

- a. Acceptance of mainline pavement placed on any production day will be based on the average density of the pavement compared to the daily average maximum theoretical density (MTD) determined for each lot of pavement placed. The average density of the field cores shall be at least 91 percent of the daily average MTD. Each individual subplot shall have an average density of at least 89 percent of the daily average MTD. If the average density of the field cores is less than 91 percent of the daily average MTD or any subplot is less than 89 percent of the daily average MTD the Unit Price of the hot bituminous pavement will be adjusted according to the following tables:

PAVEMENT DENSITY ADJUSTMENT OF UNIT BID PRICE PER LOT

Pay Factor A	Average Pavement Density
1.00	91% or greater
0.99	90.0% - 90.9%
0.975	89.0% - 89.9%
0.95	88.0% - 88.9%
0.925	87.0% - 87.9%
*	Less than 87.0%
 Pay Factor B	 Lowest Density of any Sublot
1.00	89% or greater
0.99	88.0% - 88.9%
0.98	87.0% - 87.9%
0.97	86.0% - 86.9%
0.96	85.0% - 85.9%
*	Less than 85.0%

*The Engineer will determine whether the material may remain in place. The Pay Factor for the material allowed to remain in place shall be 0.70 for Pay Factor A and 0.80 for Pay Factor B.

The density of the field cores will be determined according to the Department's *Field Sampling and Testing Manual*. The Total Pay Factor will be the product of the pay factor for the average pavement density and the lowest subplot.

$$\text{TOTAL PAY FACTOR} = (\text{PAY FACTOR A}) \times (\text{PAY FACTOR B})$$

D. **Verification Testing / Quality Control Testing Tolerances.**

A table for comparison of Verification Testing and Quality Control Testing is located in the Department's *Field Sampling and Testing Manual*.

410.06 METHOD OF MEASUREMENT.

The estimated quantities provided may be adjusted by the Engineer in the field. Any increase or decrease in the quantities used shall not be a basis for renegotiation in the price bid for these items.

- A. **Hot Bituminous Pavement.** Hot Bituminous Pavement will be measured by the Ton or Square Yard according to Section 109. Batch weights will not be permitted as a method of measurement unless the plant is equipped with an automatic batching and weighing system with an automatic printer system which prints the weights of each batch and issues a weigh ticket for each load. The tonnage will be the weight used in the accepted pavement and no deduction will be made for the weight of bitumen used in the mixture.
- B. **Bitumen.** Bitumen will be measured according to Section 109 and the quantity of bitumen will be the number of Tons or Gallons used in the accepted work.
- C. **Cored Sample.** Each individual cored sample that is removed in the required condition will be measured as a unit. The work vehicle, coring machine, masonry saw, and shadow vehicle will not be measured for payment, but will be included in the measurement of the cored sample.
- D. **Testing.** All cost incurred for the Quality Control Testing, and contractor developed mix design when specified on the plans, will not be measured separately and shall be included in the price bid for other items.

410.07 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Superpave, FAA 40	Ton
Superpave, FAA 41	Ton
Superpave, FAA 42	Ton
Superpave, FAA 43	Ton
Superpave, FAA 44	Ton
Superpave, FAA 45	Ton
Asphalt Cement	Ton or Gallon
Cored Sample	Each

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

When price adjustments are required for failing material or patching, payment will be made as follows:

- A. Determination of the payment adjustment of a lot of bituminous mixture will be made by successively multiplying the Contract Unit Price per Ton of the bid item by the applicable pay factors as determined in Sections 410.05 A, 410.05 B, and 410.05 C.
- B. When the average of the test results specified in Section 410.05 A.2 shows a larger shale content than the maximum allowable specified, the following deduction from the Bid Price for the bituminous mixture item will be made:

One percent reduction in unit price for each 0.2 percent above the maximum allowable percentage. If the percentage of shale exceeds the allowable limits by 2 percent or more, the material will be rejected unless the Engineer elects to accept it under Section 105.07.

This reduction will apply to lots of 10,000 tons, and will be applied independently of Section 410.05 A.1.

- C. Material for patching or leveling of an existing bituminous surface constructed under a previous contract shall be obtained from the tonnage provided in the basis of estimate and will be paid according to Section 408.07 C.

SECTION 411 MILLING PAVEMENT SURFACE

411.01 DESCRIPTION.

This work consists of improving the profile, cross slope, and surface texture of an existing pavement surface.

411.02 EQUIPMENT.

The milling machine shall meet Section 152.05.

411.03 CONSTRUCTION REQUIREMENTS.

- A. **Milling Pavement Surface.** The existing pavement surface shall be cleaned of deleterious material before the milling operation.

The milling shall be started at the centerline of the pavement and proceed on a longitudinal line parallel to the centerline. Succeeding passes shall progress toward the outer edge of the pavement unless a different sequence of operations is permitted by the Engineer. Milling shall progress in a manner that a single lane is not more than one day's run in advance of the adjacent lane. The Contractor may be required to alter the milling operation to best suit construction conditions. When the milling is stopped, the milled depth shall be gradually tapered to the original pavement surface.

The completed milled surface shall be free from transverse and longitudinal irregularities exceeding 1/4 inch when measured with a ten-foot straightedge.

The Contractor shall dispose of the milled material as indicated in the Contract.

When the material is stockpiled, the stockpile site shall be shown on the Plans or if not shown, the Contractor shall select the site.

The Contractor shall clean the milled surface by brooming before opening to traffic.

The Contractor shall remove equipment, materials, and residue from the roadway according to Section 107.05.

The Contractor shall place the pavement overlay within five calendar days of milling the pavement surface. The Contractor will be responsible to repair any break-ups or damage that occurs to the roadway after it is milled and prior to paving. The materials and methods used to make the repairs shall be approved by the Engineer. The cost of such repairs will be the responsibility of the Contractor and shall be included in the bid item "Milling Pavement Surface."

- B. **Prepare Stockpile Site.** The Contractor shall remove and stockpile all available topsoil, up to a maximum of 1 foot. The site shall have shaped and compacted water drains away from the salvaged bituminous stockpile. The Contractor shall furnish, place, compact, and shape to drain, a 6-inch depth of granular material, with less than 30 percent passing the No. 200 sieve over the stockpile site.
- C. **Stockpiling.** The salvaged material shall be stockpiled according to Section 106.06. Each stockpile shall be located to facilitate future processing and access to the material without interference of other stockpiles.
- D. **Restore Stockpile Site.** The Contractor shall restore the stockpile site upon completion of the Project. The unused or waste bituminous material and aggregate bedding shall be disposed of at locations acceptable to the Engineer. The stockpile site shall be lightly scarified and shaped to drain. The topsoil shall be spread uniformly over the site. The site shall be seeded and fertilized with the class of seed specified.

411.04 METHOD OF MEASUREMENT.

- A. **Milling Pavement Surface.** Milling Pavement Surface shall be measured by the Ton or by the Square Yard. The labor, equipment, brooming, cleaning/brooming water, cleaning before and after milling, water used in milling, and depositing of the milled material on the roadbed or in a hauling unit, will not be measured for payment and shall be included in the bid item "Milling Pavement Surface."
- B. **Prepare Stockpile Site.** Prepare Stockpile Site will be measured as a completed and accepted unit item to bid as a "Lump Sum." The Lump Sum shall be considered payment for removing and stockpiling topsoil; shaping and compacting subgrade; furnishing, placing, shaping, and compacting granular material; all labor, equipment, and materials required for the stockpile site(s).
- C. **Restore Stockpile Site.** Restore Stockpile Site will be measured as a completed and accepted unit item to be bid as a Lump Sum. The Lump Sum payment will be considered full payment for all disposal of wastes, spreading topsoil, compaction, blading, water, seed, fertilizer, labor, equipment and materials required to complete the item.
- D. **Stockpiled Surfacing.** Stockpiled Surfacing will be measured to the nearest 0.1 Ton of material weighed and placed in the stockpile. Loading, hauling, and stockpiling will not be measured and shall be included in the bid item "Stockpiled Surfacing."

When Stockpiled Surfacing is not a Bid Item, all loading, hauling, and stockpiling and will be included in the bid item "Milling Pavement Surface."

411.05 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Milling Pavement Surface	Ton, Square Yard
Prepare Stockpile Site	Lump Sum
Restore Stockpile Site	Lump Sum
Stockpiled Surfacing	Ton

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

SECTION 420 BITUMINOUS SEAL COAT

420.01 DESCRIPTION.

This work consists of an application of bitumen followed by an application of cover coat material on a prepared surface.

420.02 MATERIALS.

- A. **Bitumen.** The type and grade of bitumen will be specified in the Contract. The Engineer will determine the actual amount of bitumen to be used based on the chip size.

The bitumen shall meet and will be accepted according to Section 818. The bitumen will be conditionally accepted to the Project and sampled by the Contractor, according to the Department's procedures and under observation of the Engineer. The Department will test the bitumen according to the Department's *Field Sampling and Testing Manual*.

- B. **Cover Coat Material.** Cover Coat Material shall meet Section 816 for the class specified. The aggregate shall be tested in accordance with the Department's *Field Sampling and Testing Manual*.

The testing frequency is a minimum of one per day, or one per lot, whichever is greater. A lot is defined as 1,200 tons of material. If plan quantity is less than 1,200 tons, a lot will be equal to plan quantity. If the final lot is less than 600 tons, it will be included in the previous lot. If the final lot is 600 tons or greater, it will be considered a separate lot.

Three random samples will be taken for each lot of material. The samples will be tested and the material accepted if the average of the three samples meets the gradation specified. When the average of the three samples does not meet the gradation specified, the material will either be rejected or a reduction in the Contract Unit Price will be made.

If the Engineer determines a deduction is the appropriate action, a Unit Price Adjustment will be calculated as shown:

Unit Price Reduction; No. 200 Sieve: 1 percent deduction for each 0.1 percent deviation from the specification range limits.

Unit Price Reduction; Other Sieves: Percent of Deduction = $5 \times$ percent of deviation from the specification range limits.

If the aggregate fails to meet the specified gradation on one or more sieves, the reduction will be the sum of the deductions.

If the tested material deviates from the specified gradation for two consecutive lots, incorporation of additional material into the work will not be allowed until the Contractor takes the necessary corrective action to meet the Specifications.

- C. **Blotter Material.** The cover coat material shall be spread uniformly over the bituminous material with an aggregate spreader immediately after the application of the bituminous material. The Department will determine the point of acceptance for the blotter material and test it according to the Department's *Field Sampling and Testing Manual*.

420.03 EQUIPMENT.

Equipment shall meet the following:

Item	Section
General	151.01
Self-Propelled Pneumatic-Tired Rollers	151.02 B
Material-Hauling Equipment	151.03 B
Liquid Bitumen Distributors	151.05
Aggregate Spreader	151.06
Heating Equipment for Bitumen	152.01 B
Asphalt Transporter	152.06

420.04 CONSTRUCTION REQUIREMENTS.

- A. **Preparation of Surface.** Bitumen shall not be spread until the surface has been cleaned and the section has been approved.

Where the surface is broken or shows instability, the Contractor shall make the necessary repairs before placing the bitumen.

Where seal work is the only Contract item, repairs shall be done according to Section 104.03.

Where the surfacing and seal coat are included in the same Contract, surface repair work will not be paid for unless the Engineer determines the damage was through

no fault of the Contractor, in which case repairs shall be done according to Section 104.03.

- B. **Application of Bitumen.** Bitumen shall be applied with a pressure distributor in a uniform, continuous spread. The quantity of bitumen to be used per square yard shall be as directed by the Engineer. Any skipped areas or deficiencies shall be corrected. Junctions of spreads shall be carefully made to assure a smooth riding surface and complete cover.

Streaking of the bitumen on the road surface will not be allowed. Streaking is the non-uniform application of bitumen leaving alternating lean and heavy narrow bands of bitumen. If the Engineer determines that streaking is occurring, the Contractor shall cease operations until the Engineer is satisfied that streaking has been eliminated.

The surfaces of all structures and other appurtenances shall be protected against splattering. If splattering occurs, it shall be removed to the satisfaction of the Engineer at the Contractor's expense.

When traffic is maintained, the bitumen shall be applied in passes of approximately one-half the width of the completed surface. If the width of the surface makes such application impracticable, the bitumen may be applied in more than two passes.

The bitumen shall be applied so that, when covered, the overlaps caused by successive applications will not result in ridges or depressions at the transverse or longitudinal joints. The joints shall be smooth and consistent with the adjacent completed surface treatment.

To prevent lapping at transverse junctions, the bitumen spray shall be promptly shut off at the end of the application. Before continuing the application, building paper or metal sheets shall be spread a sufficient distance back from the joint on the cover aggregate so the sprayers are operating at full force when the distributor has attained the predetermined speed upon reaching the uncovered surface. All paper or metal sheets used shall be removed.

- C. **Cover Coat Material Application.** The cover coat material shall be spread uniformly over the bituminous material with an aggregate spreader. Small areas inaccessible to the aggregate spreader may be covered by hand or other approved methods.

The quantities of cover coat material shown are based on estimated rates. The actual coverage rates will be determined by the Engineer.

Immediately after the cover coat material is spread, any deficient areas shall be covered by additional cover coat material or blotter material as directed by the Engineer.

Rolling shall begin immediately behind the spreader and shall continue until a minimum of four complete coverages are obtained. The speed of the roller shall not exceed 7 MPH on the initial coverage. A self-propelled pneumatic-tired roller shall be used to complete the rolling.

The loose cover coat material shall be lightly broomed off during the cool period of early morning within 36 to 48 hours from the time of application. The broom

shall have a positive means of controlling the vertical pressure on the broomhead. Care shall be taken to avoid dislodging embedded aggregate. A final brooming shall be accomplished at the end of the maintenance period.

Excess material in curb and gutter sections shall be broomed toward the gutter and shall be picked up and disposed of by the Contractor.

1. **Requirements for Cutback Asphalts.** When using a cutback asphalt, the cover coat material shall be flushed with clear water and be well drained before it is applied to the roadway.

The cover coat aggregate shall be applied immediately following application of the bitumen.

2. **Requirements for High Float Emulsified Asphalts.** When using a high float emulsified asphalt, the cover coat material shall be flushed with water, well drained, and visibly damp when applied to the roadway.

The cover coat material shall be applied when a surface skin develops on the emulsion. The surface skin is developed when the surface of the high-float emulsion is black while a brown color remains beneath the surface. Dependent upon weather conditions, the surface skin should form in 5 to 15 minutes after application of the emulsion to the roadway.

3. **Requirements for Cationic Emulsions.** When using a cationic emulsion, the cover coat material shall be flushed with clear water and be well drained before it is applied to the roadway.

The cover coat aggregate shall be applied within one minute following application of the bitumen. If an application of emulsified asphalt is not covered before it begins to break, corrective action will be required by the Contractor at no cost to the Department.

- D. **Blotter Material Application.** The application of blotter material may be necessary to correct "bleeding." Blotter material shall be applied in the quantity and manner approved by the Engineer.
- E. **Protection of Traffic and Preservation of the Seal Coat.** The Contractor shall furnish flagpersons, pilot cars, signs, and lights according to Section 704.

On two-lane, two-way traffic highways, the Contractor shall provide additional flaggers and signs at each end of the seal operation and at major intersections within the seal operation area, to alert the traveling public to the hazards of flying chips. These flaggers and signs will be in addition to the flaggers used with the pilot car at the seal operation. The additional flaggers shall be placed immediately beyond the daily seal operation area or outside the sealed area that presents a hazard with flying chips. The flaggers will be on the project during the seal coat application operation when a pilot car is being used. Flaggers and pilot car(s) shall not be bid separately, but shall be included in the price bud for other items.

The DO NOT PASS, NO CENTERLINE STRIPE, FRESH OIL LOOSE ROCK, and SPEED LIMIT signs shall remain covered until the chip seal operation is within three miles of that portion of the project.

On four-lane highways the additional flaggers will not be required.

The seal coat shall be maintained by the Contractor during the seal coat operation and maintenance shall continue for an additional five calendar days after completion of the seal coat work. The Contractor shall repair the seal coat within two hours of the time the need for such repairs are noted.

Maintenance of the seal coat may require application of blotter sand to prevent bleeding, application of more bitumen, application of more seal aggregate, and additional rolling. The blotter sand shall be applied with a mechanical spreader such as a tailgate sander or other approved device. The sweeping of loose cover coat material from the shoulder onto the new sealed surface will not be permitted.

As soon as practicable after sealing and no later than five days after the seal has been applied, all excess cover coat material shall be swept and removed from the entire surface as directed by the Engineer.

F. Limitations.

1. **Weather.** Bitumen shall not be applied on a wet surface or when weather conditions would prevent the proper construction of the seal coat. Seal work will not be permitted when the pavement temperature is below 70°F.

Seal work shall not be started after September 1.

2. **Operational.** Prior to the application of the seal coat, each type of surface listed below shall be allowed a curing period after laydown and compaction has been completed as follows:

- a. Prime coat -- 4 days.
- b. SC, MC or RC Pavements -- 15 days.
- c. Asphalt Cement Pavements -- 7 days.
- d. Emulsion Pavements -- 15 days.

These curing periods may be increased or decreased as directed by the Engineer.

Sealing work shall not be permitted at night. Unless otherwise authorized by the Engineer, the work shall be scheduled so that the last application of the day shall be placed in time for the bitumen to cure sufficiently to allow installation of the short-term pavement marking before sunset, as specified in Section 762.04 D.1.

420.05 METHOD OF MEASUREMENT.

- A. **Bitumen.** Bitumen will be measured by the Ton or Gallon.
- B. **Cover Coat Material and Blotter Material.** Cover Coat Material and Blotter Material will be measured by the Ton or Cubic Yard or Square Yard.

420.06 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
—Liquid Asphalt	Ton or Gallon
—Emulsified Asphalt	Ton or Gallon
Cover Coat Material Class—	Ton or Cubic Yard or Square Yard
Blotter Material	Ton or Cubic Yard or Square Yard

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work. The cost of flushing the cover coat material with water shall be included in the cost of the Contract Unit Price Bid for cover coat material.

If the bid item “Blotter Material” is not included as a pay item in the Contract, payment will be made at the rate specified in the Price Schedule (PS-1) in the Proposal.

SECTION 500
RIGID PAVEMENT

SECTION 550
PORTLAND CEMENT CONCRETE PAVEMENT

550.01 DESCRIPTION

550.02 MATERIALS

- A. General
- B. Portland Cement Concrete
- C. Joint Materials
 - 1. Concrete Joint Sealer
 - 2. Fillers and Sealant

550.03 EQUIPMENT

550.04 CONSTRUCTION REQUIREMENTS

- A. General
- B. Fine Grading and Conditioning Roadbed
- C. Handling and Storing Materials
- D. Batching
- E. Measuring and Dispensing Admixtures
- F. Mixing and Transporting Concrete
- G. Placing and Spreading Concrete
 - 1. General
 - 2. Formed Paving
 - 3. Slip Form Paving
 - a. Line and Grade
 - b. Placing Concrete
- H. Placing Reinforcement
- I. Joints
 - 1. General
 - 2. Transverse Contraction Joints
 - 3. Transverse Expansion Joints
 - 4. Transverse Construction Joints
 - 5. Tie Bars and Longitudinal Joints
- J. Finishing Concrete
 - 1. Sequence
 - 2. Use of Water
 - 3. Screeding
 - a. Slip Form Paving
 - b. Other Paving Methods
 - 4. Floating
 - 5. Straightedging
 - 6. Final Surface Finish
 - 7. Imprinting Pavement
- K. Curing Concrete
 - 1. General
 - 2. Wetted Fabric Cure
 - 3. Liquid Membrane Cure
 - a. General
 - b. Application
- L. Removing Forms
- M. Sealing Joints and Cracks
 - 1. General
 - 2. Hot Poured Elastic Type Joint Seal Installation
 - 3. Silicone Joint Sealant Installation

- a. Cleaning Joints
 - b. Backer Rod Installation
 - c. Joint Sealer Application
 - 4. Preformed Elastomeric Compression Joint Seal
 - N. Protection of Pavement
 - O. Opening to Traffic
 - P. Tolerance in Surface and Ride Quality
 - 1. Surface Tolerance
 - 2. Riding Quality
 - 3. Grinding
 - 4. Pay Adjustment
 - Q. Tolerance in Pavement Thickness and Reinforcing Steel
 - 1. General
 - 2. Pavement Units
 - 3. Determination of Pavement Thickness
 - 4. Reinforcing Steel Placement
 - R. Operational Limits
- 550.05 METHOD OF MEASUREMENT
- 550.06 BASIS OF PAYMENT

SECTION 560
RECYCLED PORTLAND CEMENT
CONCRETE PAVEMENT

- 560.01 DESCRIPTION
- 560.02 MATERIALS
- 560.03 EQUIPMENT
- 560.04 CONSTRUCTION REQUIREMENTS
- A. Prepare Stockpile Sites
 - B. Stockpiling
 - C. Removing Concrete Pavement
 - D. Existing Reinforcing Steel
 - E. Processing Salvaged Concrete
 - F. Mixing
 - G. Placing
 - H. Pavement Surface Riding Quality
 - I. Determination of Pavement Thickness
- 560.05 METHOD OF MEASUREMENT
- 560.06 BASIS OF PAYMENT

SECTION 570
PORTLAND CEMENT
CONCRETE PAVEMENT REPAIR

570.01 DESCRIPTION

570.02 MATERIALS

- A. General
- B. Portland Cement Concrete for Repairs
- C. Joint Materials
 - 1. Concrete Joint Sealer
 - 2. Fillers and Sealant
- D. Dowel Bar Retrofit
 - 1. Curing Compound
 - 2. Dowel Bars
 - 3. Caulk
 - 4. Foam Core Board
 - 5. Patching Material
 - 6. Chairs
 - 7. Concrete Mix Design
- E. Joint Stitching
 - 1. Epoxy
 - 2. Tie Bars

570.03 EQUIPMENT

570.04 CONSTRUCTION REQUIREMENTS

- A. General
 - 1. Restoring the Subgrade
 - 2. Forms for PCC Repairs
 - 3. Damaged Areas
 - 4. Reinforcing Steel
 - 5. Spall Repair
 - 6. Repair Size and Longitudinal Joint Treatment
 - 7. Placing Portland Cement Concrete
 - 8. Longitudinal Joint Sealing
- B. Non-Reinforced Jointed PCC Pavement Repairs
 - 1. Existing Non-Reinforced, Jointed PCC Pavement Removal
 - 2. Work Sequence
 - 3. Bars for Transverse Joint at Full-Depth Repairs (Load Transfer)
 - 4. Transverse Joint Sealing at Full-Depth Repairs
- C. Dowel Bar Retrofit
 - 1. Sawing
 - 2. Jack Hammers
 - 3. Cleaning
 - 4. Dowel Bar Chair Placement
 - 5. Joint Caulking
 - 6. Dowel Bar Placement
 - 7. Mixing Patch Material
 - 8. Existing Concrete Surface Preparation
 - 9. Placing Patch Mix
 - 10. Curing
 - 11. Spall Repairs
 - 12. Opening to Traffic
 - 13. Grinding

- D. Joint Stitching
 - 1. Drilling
 - 2. Cleaning
 - 3. Epoxy
 - 4. Tie Bars
- E. Grinding
 - 1. Equipment
 - 2. Construction Requirements
 - a. Grinding Depth
 - b. Grinding Direction
 - c. Texture
 - d. Transitions
 - e. Slope
 - f. Clean-Up
 - 3. Ride Quality
 - a. Equipment
 - b. Calibration
 - c. Operation
 - d. Evaluation
 - 4. Joints
 - a. One-Half Inch Transverse PCC Joint Cleaning and Sealing
 - b. Longitudinal PCC Joint Cleaning and Sealing
- F. Continuously Reinforced PCC Pavement Repairs
 - 1. Existing Concrete Removal
 - 2. 24-Foot-Wide, Full-Depth Repairs

570.05 METHOD OF MEASUREMENT

- A. Spall Repair
- B. Longitudinal PCC Joint Cleaning and Sealing
- C. Full-Depth Repair Items
- D. Dowel Bars
- E. One-Half Inch Transverse PCC Joint Cleaning and Sealing
- F. ___Inch Concrete Pavement Repair (Full-Depth - Doweled)
- G. Sawcuts
- H. Full-Depth Repairs
- I. Dowel Bar Retrofit
- J. Joint Stitching
- K. Grinding
- L. One-Half Inch Transverse PCC Joint Cleaning and Sealing
- M. Longitudinal PCC Joint Cleaning and Sealing
- N. Full-Depth Repairs - End Preparation
- O. Full-Depth Repair End Prep-Mech Splice
- P. Full-Depth Continuous Concrete Repair

570.06 BASIS OF PAYMENT SUMMARY

SECTION 550 PORTLAND CEMENT CONCRETE PAVEMENT

550.01 DESCRIPTION.

This work consists of constructing a pavement composed of Portland Cement Concrete, with or without reinforcements, as specified, on a prepared subgrade or base course.

550.02 MATERIALS.

A. **General.** Materials shall meet the following:

Item	Section
Grouts and Mortar	806
Reinforcing Steel	836
Dowel Bars	836

B. **Portland Cement Concrete.** Class AE Portland Cement Concrete pavement shall consist of virgin aggregate, water, an air entrained agent, and Type I, IA, or II Portland Cement.

Material shall meet the requirements of Section 802.

C. **Joint Materials.**

1. **Concrete Joint Sealer.** The joint sealer shall be as shown on the Plans unless an alternate type is approved by the Engineer before use.
2. **Fillers and Sealant.** Materials shall meet the following:

Item	Section
Hot-Poured Joint Sealant	826.02
Silicone Joint Sealant	826.02 B
Backer Rod	826.02 B.1
Preformed Expansion Joint Filler	826.02 C
Preformed Expansion Joint Fillers (Bituminous type)	826.02 D
Preformed Elastomeric Compression Joint Seal	826.02 G

550.03 EQUIPMENT.

Equipment shall meet the following:

Item	Section
General	151.01
P.C.C. Equipment	153

550.04 CONSTRUCTION REQUIREMENTS.

- A. **General.** If a previously constructed lane of pavement is used as a side-form to support concrete finishing equipment, the pavement shall have been in place for 72 hours except when the ambient temperature is less than 40°F., then the pavement shall have reached a compressive strength of at least 3,000 psi before concrete shall be placed against it. If the previously constructed pavement is damaged during fine grading and paving operations, work shall be suspended until the cause of damage is corrected. Damaged pavement shall be replaced or satisfactorily repaired at the Contractor's expense.
- B. **Fine Grading and Conditioning Roadbed.** Hauling and mixing equipment shall not operate on the finished grade except when the operation of this equipment off the finished grade is impractical due to restricted access. When the Engineer permits equipment to be operated on the finished grade, satisfactory arrangements shall be made for protection or repair of the roadbed. During concrete placement the roadbed shall be in a smooth, compacted condition, and shall be sufficiently moist to prevent absorption of water from the concrete. Roadbeds shall be kept moist without forming of mud or pools of water.

Maintenance, repair, and restoration of the subgrade and base course before placing the concrete pavement shall be at the Contractor's expense.

- C. **Handling and Storing Materials.** Materials for concrete shall be handled and stored according to Section 802.04 A.
- D. **Batching.** Batching of concrete materials shall be according to Section 802.04 B. Aggregates and bulk cement shall be proportioned by automatic batching equipment meeting Section 153.01 B.
- E. **Measuring and Dispensing Admixtures.** Any admixture approved for use in the concrete mixture shall be measured and dispensed according to Section 802.04 C.
- F. **Mixing and Transporting Concrete.** The concrete shall be mixed and transported according to Section 802.04 D and the additional requirements of this Section.

Mixers and hauling equipment shall not be operated on the roadbed except as provided in Section 550.04 B.

Mixers and hauling equipment shall not be operated on a newly-constructed pavement except as permitted by the Engineer and according to Section 550.04 O. Any fresh concrete spilled on the existing slab shall be promptly removed.

- G. **Placing and Spreading Concrete.**
1. **General.** The concrete shall be deposited on the roadbed so segregation and unnecessary rehandling is avoided. Placement shall be continuous between all transverse joints. If concrete placement is temporarily interrupted, the unfinished face of the concrete shall be kept moist by spraying a mist over the concrete or applying wet burlap and protected against drying by covering

with burlap or plastic sheeting. When placement operations are resumed, the concrete shall be broken down and thoroughly consolidated with the fresh concrete. If the elapsed time between placement of successive batches or loads of concrete exceeds 45 minutes, a transverse construction joint shall be installed.

Concrete shall be deposited and spread so joint installations and reinforcement are not damaged or displaced.

Spreading and initial strike-off shall be performed by a mechanical spreader meeting Section 153.07. Concrete shall be spread uniformly across the full width of the slab being paved, and shall be struck off at a height which provides a proper quantity of concrete for subsequent paving operations. Other methods of spreading may be approved by the Engineer where use of a mechanical spreader is not feasible.

Immediately after the concrete is spread and struck off, it shall be thoroughly consolidated by full width vibratory equipment meeting Section 153.08. Approved portable vibratory equipment may be used where work dimensions or features do not permit use of full-width vibratory equipment.

Over vibration, evidenced by segregation of material and excessive surface mortar, will not be permitted and vibration in excess of 4 seconds in any one spot will not be allowed. Segregated area shall be removed and replaced at the Contractor's expense.

Continuous rumble strips shall be milled in both paved concrete shoulders, as shown in the Plans. Rumble strips shall not be installed in the ramp area adjacent to the mainline. The Contractor shall establish rumble strip locations and spacing.

Communications shall be provided and maintained by the Contractor between the proportioning plant and the paving operation.

2. **Formed Paving.** The roadbed shall be prepared so the forms are adequately and uniformly supported for their entire length at the established grade.

Side forms shall meet Section 153.04. The form sections shall be securely staked and free from play or movement in any direction.

After staking, the grade shall be thoroughly tamped mechanically at both the inside and outside edges of the base of the forms.

When in final position, the forms shall not deviate at any point by more than 1/8 inch from the established grade or by more than 1/2 inch from the established alignment. Forms shall be set sufficiently in advance of placing concrete to provide time for the Engineer to check line and grade. The length of forms in place shall be equal to the anticipated linear feet of pavement to be placed in 2 hours. Forms which are disturbed or show evidence of an unstable foundation shall be reset.

3. **Slip Form Paving.**
 - a. **Line and Grade.** The Department will set appropriate stakes for establishing the finished line and grade of the pavement. The Contractor shall

erect and maintain the necessary taut lines for operating the automatic equipment and preserve the line and grade stakes set until the pavement is placed.

- b. **Placing Concrete.** When placing concrete pavement on a divided highway, the inside mainline shoulder and the two driving lanes shall be placed in one continuous operation. Concrete shall be uniformly placed at a rate and consistency that produces a dense and homogeneous pavement with a minimum amount of manual finishing.

The slip form paver shall be operated in a continuous forward movement. All concrete mixing, delivering, placing, and spreading operations shall be coordinated to provide a continuous and uniform forward movement without stopping and restarting the paver.

During paving operations, a constant and uniform head of concrete shall be maintained in front of the paver. This head shall be maintained at a depth within the range of 0.5 to 2 times the depth of the finished slab.

- (1) **Consolidation – Vibrator Operation.** The slip-form paving equipment shall consolidate the full width and depth of concrete in a single pass, using an approved internal or surface vibrator. Internal vibrators shall penetrate into the concrete pavement slab to mid slab or as deep as possible while passing above any reinforcing steel. An operating position-locking device shall be provided so that no part of the vibrating unit can be lowered to the extent that it will come in contact with reinforcing steel or tie bars while paving. Internal vibrators shall be operated within a frequency range of 4,000 to 8,000 vibrations per minute. The Engineer may authorize the minimum vibration frequency lowered to 3,500 vibrations per minute for particular sections of paving such as super elevations. However, in no case shall the frequency exceed 8,000 vibrations per minute. Surface vibrators shall be operated within a frequency range of 3,500 to 6,000 vibrations per minute. Vibrators shall not be operated in a manner to cause segregation of the mix ingredients (either a downward displacement of large aggregate particles or an accumulation of laitance on the surface of the concrete). Mix-segregation avoidance may require a reduction in vibrator frequency when forward motion of the paver is reduced.

If a vibrator fails to operate within the specifications, the Contractor shall repair or change the vibrator before the paving begins the following day or begins the same day, if the continuous paving is stopped at a header or at the end of a session.

If two adjacent vibrators fail to operate within Specifications, the paving operation shall stop and repairs made or vibrators replaced.

Vibrators shall be stopped whenever forward motion of the paver is stopped.

A vibrator monitor shall be operated to record, at a minimum, the clock time, station location, paver track speed, and operating fre-

quency of individual vibrators. Recordings shall be made after each 25 feet of paving or after each five minutes of time, whichever occurs first. An electronic and printed record of the data shall be provided to the Engineer, daily. The Engineer may determine that more frequent submission is necessary, particularly if equipment malfunctions occur. Either the printed or electronic records (or both) shall be produced in their final form prior to the records being removed from the paver (i.e. the Contractor shall either produce a printout or diskette from the recording device, on the paver and present this record to the Engineer, in the field). If only one record is produced at the paver, the other may be produced in an office. However, the first record shall be presented to the Engineer prior to any of the data entering an office environment. The electronic record shall be a comma or spaces delimited text file, adequate for insertion into a computerized spreadsheet software package. Additionally, the Contractor shall, once per week (or as directed by the Engineer), provide a written explanation of vibrator setting changes, out-of-tolerance vibratory operations, and monitoring-device malfunctions.

If the electronic monitoring device fails to operate properly, the vibrators shall immediately be checked manually. If the vibrators are functioning properly, paving may continue, but the Contractor shall make all efforts to correct the malfunction in a reasonable amount of time. If the recording device fails to operate, paving may continue but the Contractor shall correct the malfunction within three paving days. The Engineer may allow additional time if, in the sole opinion of the Engineer, circumstances are beyond the Contractor's control.

- H. **Placing Reinforcement.** Reinforcement, when specified, shall be installed according to details shown on the Plans. The reinforcing steel shall be free from dirt, oil, paint, grease, mill scale, and loose or thick rust which could impair the bond between the steel and concrete.

The reinforcement shall be positioned on approved supports in advance of the concrete placement or inserted in the plastic concrete by an approved mechanical device.

The Contractor shall verify the placement of reinforcement in the plastic concrete pavement. At minimum, the reinforcement location will be verified at the start of paving each day and at a frequency of every 500 feet during normal paving.

On projects with over 20,000 SY of concrete paving, the location of the reinforcement shall be verified by the use of a micro covermeter. The Contractor shall provide the micro covermeter and, at the request of the Engineer, allow the Department personnel to confirm bar locations with the micro covermeter.

If the reinforcement does not meet the requirements and tolerances specified for the placement of the reinforcement, corrective action shall be taken immediately and performed at the Contractor's expense.

I. **Joints.**

1. **General.** Joints in concrete pavement shall be of the design specified and shall be constructed at the spacings and locations shown. The ramp joints be-

yond the ramp taper shall have the same spacing sequence as the mainline. The Contractor shall establish joint locations.

2. **Transverse Contraction Joints.** The contraction joints shall consist of weakened planes created by sawing on main line and shoulders, and by either sawing, inserting preformed inserts, or forming grooves in the pavement surface on small areas or tapers. The location of grooves to be formed or sawed shall be clearly and accurately marked on the plastic concrete surface by the Contractor. When specified, the contraction joints shall include a load transfer device.

Sawed contraction joints shall be cut to the required dimensions with equipment meeting Section 153.12. The time and sequence of sawing shall be adjusted so all joints are cut before uncontrolled cracking occurs, and to permit sawing without excessive raveling. Joints shall be sawed within 24 hours to prevent uncontrolled cracking. Uncontrolled cracking that occurs shall be routed, cleaned and sealed according to Section 550.04 M.3 at the Contractor's expense. Immediately after sawing, the joint shall be flushed with water under sufficient pressure to remove residue left by the sawing operation. If an uncontrolled crack occurs within 5 feet of any proposed joint location before or during sawing, the joint shall be omitted and sawing of the joint discontinued. Any joint sawed within 5 feet of an uncontrolled crack shall be repaired at the Contractor's expense. When sawing is performed before removing side forms, the initial saw cut will extend to within 1/2 inch or less of the side forms. If the forms have been removed, the saw cut will be extended to the edges of the slab. Any curing media removed during sawing shall be immediately replaced.

Before installing silicone sealant or preformed elastomeric compression joint seal, all joint grooves shall be inspected and spalls which are greater than 1/4 inch in depth shall be repaired by patching with an approved epoxy mortar meeting Section 806. Loose concrete shall be removed from the spalled area and the area shall be thoroughly cleaned. Heavy sheets of polyethylene, polyvinyl chloride, or other suitable material which do not bond to the epoxy shall be inserted in the joint groove to form the faces of the spalled patch. After cleaning, the spalled surface shall be primed with a brush application of epoxy binder, and an epoxy mortar of troweling consistency shall be placed in the spalled area and finished as the original pavement surface. The epoxy binder components shall be mixed in proportions and by methods recommended by the manufacturer. After the epoxy binder is thoroughly mixed, dry concrete sand shall be blended into the mixture to give an epoxy mortar of trowelable consistency. Patching of spalls shall be done only when the air and pavement temperature is above 40°F. Dry concrete sand shall be sprinkled onto the fresh epoxy mortar surface to eliminate any gloss. After the epoxy mortar has cured, the inserts shall be removed.

Formed contraction joints shall be constructed by installing an approved preformed insert into the plastic concrete before final surface finishing. The inserts shall be vibrated into place or installed in a groove formed by a vibrating cutter bar. The inserts top edges shall be flush with the concrete surface. Any voids, depressions, or ridges of concrete caused by installing inserts shall be filled or removed by hand-finishing methods, and the surface across the joint shall be straight-edged according to Section 550.04 J.5. The groove formed

by the inserts shall be perpendicular to the pavement surface, true to the required alignment, and continuous along the full length of the joint. Inserts, except those designed to remain, shall be removed without damage to adjacent concrete.

When specified for use with the transverse contraction joint the dowel bars shall be held in the specified position parallel to the slab surface and to the centerline within a tolerance of 1/8 inch per foot vertically and horizontally. The dowel bar assembly shall be an approved metal supporting device securely staked to the roadbed and shall hold the dowel bars at the correct spacing, alignment and elevation. The position of the load transfer units shall be accurately marked with steel pins, or other precise methods, to locate the transverse joint over the center of the dowels. After the dowel bar assembly is staked to the roadbed and the dowel bars are held firmly in place, the assembly ties running parallel to the dowel bars shall not be cut, but remain in place.

Dowel baskets shall be placed ahead of the paving operation with sufficient distance to allow adequate time to be properly inspected.

A uniform coat of Tectyl 506, NLGI Grade #2 multipurpose lithium grease, an approved equal, shall be applied by the manufacturer to the full length of the dowel bars to act as a release agent.

3. **Transverse Expansion Joints.** The expansion joints shall be formed by installing preformed expansion joint filler at designated locations.

Dowel bars shall be installed in the expansion joint to act as a load transfer device. The dowels shall be held in the specified position parallel to the slab surface and centerline by a metal supporting device securely staked to the roadbed and shall hold the dowel bars at the correct spacing, alignment, and elevation. The dowel bars shall be placed within a tolerance of 1/8 inch per foot vertically and horizontally. The "free" half of each dowel shall be coated with a thin uniform coat of Tectyl 506, NLGI Grade #2 multipurpose lithium grease, or an approved equal, as the release agent, and covered with a metal or plastic dowel cap or sleeve. The caps or sleeves shall fit the dowel bars tightly and the closed end shall be watertight. After the dowel bar assembly is staked to the roadbed and the dowel bars are held firmly in place, the assembly ties running parallel to the dowel bars shall not be removed but shall remain in place to maintain the proper alignment of the dowel bars.

Preformed expansion joint filler shall be of the dimensions shown on the Plans and shall extend across the full width and depth of the slab at each transverse expansion joint. Filler shall be furnished in individual sections having a length equal to the pavement slab width being poured. Filler shall be accurately pre-punched to fit snugly around the dowels.

The expansion joint assembly shall be securely staked to the subgrade. Unless the preformed filler is adequately supported by a load transfer assembly or other device designed to remain in the pavement, a suitable installing bar or header shall be used to support filler during placement and finishing of adjacent concrete. Filler shall be installed perpendicular to the pavement surface and true to the designated line of the joint. Where more than one section of filler is permitted, abutting ends of individual sections of filler shall be

neatly and securely jointed without any gap or offset between sections. The bottom edge of filler shall extend to or slightly below the bottom of the pavement. The top edge of filler shall be approximately 1/2 inch below the pavement surface. During placement and finishing of adjacent concrete, the top edge of filler shall be protected by a removable channel cap having flanges not less than 1-1/2 inches deep. An aluminum channel cap shall not be used.

Installation of the expansion joint assembly shall be approved before any concrete is placed against the joint. Equal pressure shall be maintained against both sides of the preformed filler as the concrete is placed, and an approved internal vibrator shall be used to consolidate the concrete on each side of the joint. After the concrete has been placed and finished, the protective channel cap shall be removed, the top edge of the filler shall be exposed over its full width and length, and the concrete on each side of the joint shall be edged to the specified radius. After the side forms have been removed, any concrete which flowed around the ends of the joint shall be removed to expose the full thickness and height of the filler.

The expansion joint shall be sealed with a low modulus silicone sealant meeting Section 826.02 B. All materials and installation methods shall meet Section 550.04 M.3.

At structures projecting through, into, or against the pavement, expansion joints of a preformed or poured type shall be constructed as specified.

4. **Transverse Construction Joints.** A transverse construction joint shall be installed at the end of each day's pour and whenever the elapsed time between placement of successive batches or loads of concrete exceeds 45 minutes. Transverse construction joints shall be installed halfway between 2 normally spaced transverse joints.

The transverse construction joint shall be formed by installing an approved dowel splicer bar basket assembly. The dowel splicer bar assembly shall hold the dowel splicer bars parallel to the centerline and slab surface. The dowel splicer bars shall be placed within a tolerance of 1/8 inch per foot vertically and horizontally.

The dowel splicer basket assembly shall be staked perpendicular to the centerline and marked. The Contractor shall pave over the assembly far enough to maintain the elevation of the top of the slab. A full depth saw cut shall be made to expose the dowel splicer bar, the excess concrete shall be disposed of and the threaded dowel extension bar shall be installed.

After the adjacent slab is placed the construction joint shall be sawed and sealed as specified.

On shoulders or urban projects where the Engineer determines it is not feasible to install a dowel splicer bar basket assembly the transverse construction joint shall be formed by installing an approved header shaped to conform to the cross-section of the slab being placed. The header shall be rigid and secured to prevent bulging or displacement while adjacent concrete is being placed and finished. The face of the header in contact with the concrete shall be perpendicular to the pavement surface and shall be at right angles to the

pavement centerline. A two-piece or other approved header shall be designed to accommodate proper placement of any dowel bars or reinforcement extending across the joint and to allow removal without damage to the concrete.

The concrete adjacent to the header shall be thoroughly consolidated by an internal vibrator or other approved methods. Segregated or improperly consolidated concrete shall be removed. After the pavement has been finished, the surface adjacent to the header shall be edged to the specified radius.

5. **Tie Bars and Longitudinal Joints.** Tie bars or tie bar baskets shall be held in the specified position parallel to the slab surface and perpendicular to the centerline by a supporting device securely staked to the roadbed and shall hold the tie bars or tie bar baskets at the correct spacing, alignment, elevation, and within tolerance. Tie bars will not require support if inserted into the side of the pavement during slip form paving of the longitudinal construction joint operation. Tie bars or tie bar baskets shall be placed so that they are not within 15 inches of the intersection of the longitudinal joint and transverse joint.

The tie bars final position shall be within the following tolerances:

- Vertical Placement ± 1 inch
- Transverse Placement ± 3 inches

The location of the tie bars under the longitudinal joints will be randomly checked twice a day to assure that their location is within the allowable tolerances. Failure to acquire the correct tie bar location shall require supporting the tie bars on chairs.

- a. **Longitudinal Weakened-Plane Joints.** Planes of weakness for longitudinal joints shall be created by sawing grooves in the pavement surface. Grooves shall be sawed to meet dimensions shown and shall be true to the required alignment of the joint.

Equipment for sawing longitudinal joints shall meet Section 153.12. As sawing progresses, the joint shall be immediately flushed with water under sufficient pressure to remove residue left by the sawing operation. If sawing is performed before expiration of the required curing period, any curing media removed shall be immediately replaced after flushing. Sawing of longitudinal joints shall be completed within seven days after concrete placement.

- b. **Longitudinal Construction Joints.** The longitudinal joint between adjoining, separately constructed lanes of pavement shall be constructed as shown on the Plans. Tie bars across longitudinal construction joints shall be at the locations, spacing, and depth shown. Tie bars may be bent at right angles against the form of the first lane constructed and straightened into final position before the concrete of the adjacent lane is placed. The bars may be inserted through small, accurately positioned holes in the side forms; approved two-piece connectors may also be used.

J. Finishing Concrete.

1. **Sequence.** After concrete has been placed, spread, and vibrated according to Section 550.04 G, the sequence of finishing operations shall be screeding,

floating if required, straight edging, final surface finishing, and edging at forms and joints.

2. **Use of Water.** When weather conditions cause rapid drying of the pavement surface a fine mist or fog spray shall be applied to the concrete surface for interim curing. Use of brushes to apply water and use of water to facilitate finishing will not be permitted.
3. **Screeding.**
 - a. **Slip Form Paving.** When the concrete is placed with a slip form paver, the screeding shall be done by the paver.
 - b. **Other Paving Methods.** Machine methods shall be employed to screed and consolidate the concrete, except where the Engineer determines the use of machine methods is not feasible. If the screeding machine breaks down the concrete that was mixed at the time of breakdown, may be manually screeded provided the final product meets specified requirements. If the finished work is unsatisfactory, it shall be repaired or removed and replaced at the Contractor's expense.

Transverse screeding machines meeting Section 153.09 shall be operated over each area of pavement as many times as necessary to produce a surface having a uniform texture meeting the required crown and gradient. Each section of pavement shall be finished by two transverse screeding machines operating simultaneously. The forward speed of the screeding machines shall be coordinated with the rate of concrete placement to avoid frequent or unnecessary stops in the final screeding movement. The screeds shall be adjusted so a small quantity of concrete or mortar is carried ahead of each screed. Screeds shall be operated to avoid displacing or damaging joint installations. Segregated concrete or mortar carried ahead of the screeds shall not be deposited on or adjacent to any joint. If concrete is placed at a rate of less than 250 feet per hour, one screeding machine may be used provided results are satisfactory and the screeding machine is operated at least twice over each area of pavement.

- c. **Bridge Approach Slabs.** Mechanical finishing of bridge approach slabs shall be required. A mechanical or hand-held transverse metal tine finish shall be applied. Tining shall start 6 inches from the beginning and end of the bridge approach slabs. The surface tolerance of the finished slabs shall be 3/16 inch in 10 feet.

The Contractor has the option of placing the concrete in one continuous operation or two pours with the split determined by a centerline joint.

4. **Floating.** Long-handled floats, having blades at least 5 feet in length and 6 inches in width, may be used to smooth and fill in open-textured areas of pavement.
5. **Straightedging.** While the concrete is still plastic, the Contractor shall test the slab surface for trueness with a 10-foot straightedge meeting Section 153.10 B. The straightedge shall be placed parallel to the pavement centerline and shall be passed over the slab to reveal any high areas or depressions. High

areas shall be struck off and low areas shall be filled with fresh concrete. The areas corrected shall be consolidated and refinished with a long-handled float. Hand floats shall be operated across the pavement by starting at the edge and slowly moving to the crown and back again to the edge. The float shall then be moved forward and the operation repeated. Only enough floating shall be done to seal the surface and care shall be taken to preserve the required cross section of the pavement. The surface shall be checked again with a 10-foot straightedge and any irregularities eliminated. Surplus water or laitance on the pavement surface shall be wasted outside the forms. Successive advances of the straightedge along the pavement shall lap the previously straightedged area by not less than 1/2 the length of the straightedge. Special attention shall be given to assure the surface across joints meets requirements for smoothness. Straightedge testing and surface corrections shall continue until the entire surface is free from observable depression below the straightedge, and the slab conforms to the required grade and cross section.

6. **Final Surface Finish.** After surface irregularities have been removed and before the concrete attains an initial set, a seamless strip of stiff-fiber artificial grass carpet shall be dragged longitudinally along the full width of the pavement. The surface texture shall be uniformly roughened leaving corrugations in the surface that are uniform in appearance. The width of material in the drag shall be in contact with the full width of the pavement. The drag shall be operated off of a string-line with its leading edge attached to a bridge riding on the forms or adjacent slabs. The drag shall be maintained clean and free from encrusted mortar. A drag that can not be cleaned shall be replaced with new fabric.

Immediately following the carpet drag, the surface of the concrete pavement shall be given a longitudinal metal-tine finish over the entire driving surface, as specified below. However, the slab shall not be tined within 3 inches of the edge of the slab or centerline.

Tining devices shall be maintained clean and free from encrusted mortar and debris to ensure uniform groove dimensions. The longitudinal metal-tine finish shall provide a groove with of 1/8 inch \pm 1/64 inch, a groove depth of 3/16 inch \pm 1/16 inch, and a uniform spacing of 3/4 inch between individual grooves.

At transverse joints, the saw cut locations shall not be protected from tining. The tining shall be continuous across the joint.

7. **Imprinting Pavement.** After texturing, the survey station numbers shall be imprinted into the surface by the Contractor about 1 foot from the edge of the pavement so the numbers can be read in the direction of traffic driving on the outside shoulder. The station markings shall be imprinted every 500 feet and "tick" marks shall be imprinted at 100-foot intervals between the 500-foot station markings. On two-way roadways, the station numbers shall be imprinted in the direction of stationing. In addition at the beginning and end of each day's pour, the station number to the nearest foot shall be placed at the right edge of slab.

The month, day, and year shall be imprinted at the beginning and end of each day's pour near the edge of the slab opposite that used for stationing so the numbers can be read in the direction of the pour.

An “O” shall be imprinted at each edge drain outlet location. Outlets occur approximately every 500 feet.

At each reference point (RP), the RP number shall be imprinted into the pavement. The imprints will occur approximately one per mile.

The Contractor shall furnish devices for imprinting the pavement. The numerals shall be 3 to 4 inches in height and at least 1/4 inch in depth.

8. **Rumble Strips.** When a bid item is included in the Plans, the quantity for rumble strips is measured by project length for each shoulder per mile, and paid for by Plan quantity. No deduction in length will be made for discontinued rumble strips as identified in the notes in the Standard Drawings.

K. Curing Concrete.

1. **General.** Curing shall be accomplished using a wetted fabric cure or an impervious membrane cure. Any specified method of cure may be used but methods shall not be changed without approval. All concrete pavement shall be cured for a period of at least 72 hours unless high-early strength concrete is utilized. Curing may be suspended for high-early strength concrete when the pavement has attained the minimum strength specified in Section 550.04 O. for opening pavement to public traffic. Curing shall begin as soon as the curing cover can be placed without marring the concrete. If hair-cracking develops before placing the curing cover, curing procedures shall be modified to prevent loss of moisture by utilizing a fog spray of water or a wetted fabric. If hair-cracking continues, concrete placing and mixing shall be suspended until a solution has been found. Failure to provide (a) sufficient cover material of the type specified or (b) the interim cure utilizing a moist fog or moist fabric, will be cause for immediate suspension of concreting operations. No pavement shall be left exposed more than 30 minutes without the applied final cure.
2. **Wetted Fabric Cure.** This method of curing consists of covering pavement with wet mats of cotton, burlap, geotextile fabric, or other approved highly-absorptive fabric. Mats shall be placed to cover the entire pavement surface and, the exposed sides of the pavement when the forms are removed. Fabric mats shall be kept wet to maintain free water on the pavement surface continuously during the curing period. The fabric mats shall remain in position for at least 72 hours, or a minimum of 12 hours if the mats are replaced with impervious membrane.
3. **Liquid Membrane Cure.**
 - a. **General.** A uniform film of an impervious, Type II, Class B, white pigmented membrane cure shall be sprayed over the concrete pavement surface immediately after finishing. The curing compound shall be thoroughly mixed and applied with spraying equipment meeting Section 153.11. Curing cover that is damaged within the curing period shall be immediately recoated. If side forms are removed before expiration of the curing period, the exposed sides of the pavement shall be immediately sprayed with curing compound at the rate specified for the pavement surface.

- b. **Application.** The impervious compound shall be applied to the pavement surface in one or two applications. If two applications are utilized, the second application shall be made within 30 minutes of the first application. The total rate of application shall be at least one gallon per 150 square feet of pavement. Joints requiring sealing shall be protected against entry of curing compound.

- L. **Removing Forms.** Side forms shall remain in place for at least 8 hours, and until the concrete has hardened to the extent that the forms can be removed without damage to the concrete. Pry bars shall not be used against any new pavement to remove forms. Any pavement damage resulting from form removal or use of form pullers shall be repaired at the Contractor's expense.

Before applying curing compound, honeycombed areas in the sides of the pavement or curb shall be repaired using freshly mixed mortar of the same proportions of cement and sand as used in the pavement concrete. If honeycombing occurs frequently, adjustments shall be made in the placement methods, including additional vibration at the form lines if directed by the Engineer.

- M. **Sealing Joints and Cracks.**

- 1. **General.** Within ten days after concrete placement and before opening the pavement to public or construction traffic, the joints shall be sealed with specified joint material. Before sealing, each joint shall be thoroughly cleaned of all dust, dirt, concrete scale, and other foreign matter and blown out with a jet of compressed air. The joint faces shall be clean and dry when the joints are sealed. Joints shall not be sealed when the air temperature is below 40°F.

When the asphalt shoulder joint is to be sealed, the edge of the P.C.C. pavement shall form one vertical side of this joint and shall be cleaned by a device which results in a smooth clean surface. The vertical face of the joint in the asphalt surfacing shall be smooth and vertical, and the line of its edge shall be straight and parallel to the edge of the P.C.C. pavement. The bottom of this joint shall be smooth and level.

- 2. **Hot Poured Elastic-Type Joint Seal Installation.** The joint shall be filled with an applicator meeting Section 153.13 B. from the bottom up to the required depth.
- 3. **Silicone Joint Sealant Installation.**
 - a. **Cleaning Joints.** Joints shall be sawed and blown out with compressed air at a working pressure of at least 90 psi.

Before installing silicone sealant, the vertical joint faces shall be cleaned by sandblasting. Oil, asphalt, curing compound, paint, rust, and other foreign materials shall be completely removed. The joint shall be blown out with compressed air immediately before installing silicone sealant. All incompressible materials shall be removed from the joint slot.
 - b. **Backer Rod Installation.** Backer Rod shall be installed in transverse joints in a manner and at a location that produces the shape factor (width and depth) for the sealant specified.

- c. **Joint Sealer Application.** The joint sealer shall be applied by an approved mechanical device.

Sealant shall be applied from inside the joint and squeezed against the sides of the joint to provide good adhesion. Sealant surface shall be tooled to produce a slightly concaved surface approximately 1/4 inch below the pavement surface. Sealants that are not self leveling shall be tooled before a skin forms on the surface. Soap or oil shall not be used as a tooling aid.

Failure of the joint material in either adhesion or cohesion in the first year, will be cause for rejection. Repair shall be at the Contractor's expense.

4. **Preformed Elastomeric Compression Joint Seal.** Immediately before installation of the preformed joint seal, joint grooves shall be thoroughly cleaned of all foreign material using a jet of compressed air at a working pressure of at least 90 psi. The lubricant-adhesion shall be applied to the joint groove walls or to the preformed joint seal or both. The preformed compression joint seal shall be installed by suitable machine tools. On ramps or locations where machine tools would not be practical, hand tools may be used. The seal shall be installed not less than 1/8 inch or more than 1/4 inch below the pavement surface and shall be free from curling or twisting in the joint groove.

Joints having a length of 30 feet or less shall not contain any splice of the joint seal. Joints having a length over 30 feet shall not have more than two splices of the joint seal. The preformed joint seal shall extend one inch beyond each edge of the concrete pavement, and stretching of the preformed joint seal more than 5 percent is not permitted.

- N. **Protection of Pavement.** The newly-placed concrete shall be protected from traffic by employing watch persons, if necessary, and by the erection and maintenance of barricades, fences, warning signs and lights, pavement bridges, and cross-overs.

When the temperature is expected to fall below 35°F., suitable measures shall be taken to maintain the concrete surface temperature above 40°F. for five days. Admixtures for curing or temperature control shall be used only as permitted or directed. The admixtures shall not be considered as a substitute for any specified curing requirement.

Any concrete pavement damaged before final acceptance, including damage by frost action, shall be repaired or removed and replaced at the Contractor's expense.

When bituminous pavement or any colored concrete is applied adjacent to P.C.C. pavement, the adjacent P.C.C. pavement shall be protected from spills and smears. Discolored P.C.C. pavement shall be cleaned at the Contractor's expense. The P.C.C. pavement shall not be used to stockpile or mix any material unless approved by the Engineer.

- O. **Opening to Traffic.** Newly constructed concrete pavement shall not be opened to public traffic until the concrete has attained a flexural strength of 450 psi or a compressive strength of 3,000 psi. Specimen beams and cylinders used for testing

shall be cured under the same conditions as the concrete pavement or cores may be taken from the pavement. Pavement that has not reached the required flexural and compressive strengths shall not be opened to public traffic or heavy equipment until it has aged at least 14 days. In addition to the strength requirements, the newly constructed concrete pavement shall not be opened to public traffic until all joints have been sealed. Construction traffic may be permitted on the concrete pavement when all of the following conditions have been met:

1. The strength requirements are met,
2. The initial relief cut has been made on all joints, and
3. Joint widening (or the second joint cut) has not been done on any joints, unless the widened joints have been sealed, in conformance with the final plan requirements.

P. Tolerance in Surface and Ride Quality.

1. **Surface Tolerance.** After the concrete has hardened sufficiently, the pavement surface shall be tested with a 10-foot straightedge. The surface tolerance shall be based on the posted speed limit as follows:
 - a. In areas where the posted speed limit is 40 mph or greater, high spots of more than 1/8 inch but not exceeding 1/2 inch in 10 feet shall be ground with diamond grinding equipment to an elevation where the deviation is less than 1/8 inch. When the deviation exceeds 1/2 inch the area shall be ground with diamond grinding equipment or the pavement shall be removed and replaced at the Contractor's expense.
 - b. In areas where the posted speed limit is less than 40 mph, high spots of more than 1/4 inch but not exceeding 5/8 inch in 10 feet shall be ground with diamond grinding equipment to an elevation where the deviation is less than 1/4 inch. When the deviation exceeds 5/8 inch the area shall be ground with diamond grinding equipment to the specified 1/4 inch deviation or the pavement shall be removed and replaced at the Contractor's expense.

If corrective grinding is required and more than 1/2 inch of concrete is removed from any area ground, the area shall be cored. If the core is deficient in length, the unit price for the deficient area will be adjusted according to Section 550.06 A.

If an area of pavement is removed, it shall be at least 6 feet in length and at least the full width of the lane involved. If the limits of removal extend to within 6 feet of a transverse joint, the pavement shall be removed to that joint. The Contractor shall repair the area as directed by the Engineer, including installing dowel bars at each end of the repair.

For pavement constructed by the slip-form method, the edge settlement shall be determined as soon as practical after paving operations begin. Any edge settlement in excess of 3/8 inch shall be corrected before the concrete has hardened. When edge settlements in excess of 1/4 inch persist, paving shall be suspended and operational corrections made before resuming paving operations.

2. **Riding Quality.**

Surface smoothness will be determined for all mainline pavement where the posted speed limit exceeds 40 mph. Mainline pavement is defined as all traffic lanes excluding acceleration lanes, deceleration lanes, tapered sections, widening, and shoulders. The profile will be terminated 20 feet from each bridge and 20 feet from existing pavement which is joined by the new pavement.

The Portland Cement Concrete pavement shall be placed and finished to produce a surface with a profile of 0.5 inch or less per 0.1 mile. Pavement smoothness and riding quality will be determined by a California Profilograph. The profile will be taken on two lines, 8 feet left and right and parallel to the centerline of the mainline pavement. Added profiles may be taken to define limits of an out-of-tolerance surface.

Computerized profilographs must use a third-order Butterworth filter with a cutoff wavelength of 2.0 feet. The computer shall generate a profile index using a 0.2-inch blanking band and use a 0.3-inch bump threshold to identify "must grind" locations. Each profilogram trace shall show blanking band, data filtering, must grinds, stationing, project number, lane, date tested and operator's name. Profilogram traces shall be taken in the same direction as the paver and at a speed no greater than a normal walk. The manufacturer's operator's manual shall be used for calibration and operating instructions.

All areas represented by high points having deviations in excess of 0.3 inch in 25 feet or less shall be ground with diamond grinding equipment at the Contractor's expense. Diamond grinding shall be conducted for a minimum of one 12-foot lane and one panel length. On pavement sections where corrections are necessary, second profilograph runs will be performed to verify that corrections have produced a Profile Index of 0.9 inch or less per 0.1 mile. If the initial Profile Index is less than 0.5 inch per 0.1 mile, only the areas representing 0.3-inch deviations will be reprofiled for correction verification. All corrective work shall be completed before determining pavement thickness.

If corrective grinding is required and more than 1/2 inch of concrete is removed from any area ground, the area shall be cored. If the core is deficient in length, the unit price for the deficient area will be adjusted according to Section 550.06 A.

3. **Grinding.** Grinding and texturing shall be completed utilizing diamond blades, mounted on a self-propelled machine, designed for grinding and texturing of pavements. The equipment shall not cause strain or damage to the underlying surface of the pavement. Grinding and texturing equipment that causes excessive ravels, aggregate fractures, spalling, or disturbance of the joints shall not be permitted.

Grinding shall be performed in the longitudinal direction so grinding begins and ends at lines normal to the pavement centerline. The maximum allowable overlap between passes shall be 2 inches and the maximum allowable depth variance between adjacent passes shall be 1/8 inch. The pavement shall be ground and textured until the pavement surface meets the riding quality specified in Section 550.04 P.2. The grinding shall be feathered out as directed by the Engineer.

The surface of the ground pavement shall have a texture consisting of grooves between .090 and .130 inches wide. The peaks of the ridges shall be approximately 1/32 inch higher than the bottom of the grooves.

High shoulders shall be ground to provide drainage and safety.

The pavement shall be left in a clean condition. The removal of all slurry or residue resulting from the grinding operation shall be continuous. The grinding operation should be controlled so the residue from the operation does not flow across lanes utilized by traffic.

4. **Pay Adjustment.** When the average Profile Index does not exceed 0.5 inch but is greater than or equal to 0.3 inch per 0.1 mile, payment will be made at the Contract Unit Price for the completed pavement. When the average Profile Index is less than 0.3 inch per 0.1 mile, an incentive payment will be made for the completed pavement. When the average Profile Index exceeds 0.5 inch per 0.1 mile but does not exceed 0.9 inch per 0.1 mile, the Contractor may accept a Contract Unit Price adjustment in lieu of reducing the Profile Index. Contract Unit Price adjustments will be made according to the following schedule in those cases where the Contractor elects not to grind. Price adjustments for pavement that has been ground to reduce the Profile Index will be according to the following schedule, except no bonus will be paid.

Profile Index Inches Per 0.1 Mile	Contract Unit Price Adjustment
Less than 0.30	\$0.50/square yard bonus (a)
0.30 to 0.50	Contract Unit Bid Price
0.51 to 0.70	\$1.00/square yard deducted (b)
0.71 to 0.80	\$2.00/square yard deducted (b)
0.81 to 0.90	\$3.00/square yard deducted (b)
Over 0.90	Corrective work required

- a. Unit bid price adjustment will be paid only when both adjacent 12-foot driving lanes meet the indicated surface smoothness. To qualify for bonus payment, each lane must have a measured profile index of less than 0.30 inches per 1/10 (0.1) mile for five or more consecutive 0.1 mile increments. A length of 25 feet on each side of each transverse construction joint (header) will be exempted from this requirement. The bonus payment will apply to the total area of the 1/2 (0.5) mile or more segment (two lanes, 24 feet wide) minus the exempted areas at the headers. No bonus will be paid in any segment if there is any grinding outside of the exempted areas.

If a header exemption area has a deviation in excess of 0.3 inch per 25 feet, the Contractor shall remove the high points with a diamond grinding device.

- b. Unit bid price adjustment will apply to the total area of the 0.1-mile segment of pavement, for the lane width represented by the profile of the driving lane (12 feet wide). A paving section less than 0.1 mile shall be added to the subsequent day's paving operation to total 0.1 mile.

Payment for any pavement which has an average Profile Index greater than 0.9 inch per 0.1 mile will be made at Contract Unit Price minus \$4.00/square yard until corrective work has been completed and the pavement reprofiled to verify a reduction in the average Profile Index to 0.9 inch or less.

Q. Tolerance in Pavement Thickness and Reinforcing Steel.

1. **General.** Pavement shall be constructed to the specified thickness. Before final acceptance of the work, the pavement will be cored by the Department, and the pavement thickness determined by measuring the cores according to AASHTO T 148. Pavement which is deficient in thickness by more than 0.2 inch shall be subject to adjustments in Contract Unit Price as provided in Section 550.06 A. Areas of pavement deficient in thickness by more than one inch shall be removed and replaced.
2. **Pavement Units.** When adjustments in Contract Unit Price are required due to deficient pavement thickness, the pavement will be divided into units as follows:

Mainline pavement of each specified thickness and of each separate pour width will be divided into basic units of 4,000 square yards each. The remaining fractional area adjacent to the end of each mainline pour width will be considered as a separate unit if the fractional area exceeds 1,000 square yards, or will be included in the adjacent basic unit if the area does not exceed 1,000 square yards.

An individual ramp, cross-over, intersection, shoulders, or other irregular area of pavement not included in the main line will be considered as separate 4,000 square yard units for determination of pavement thickness. The Engineer will determine which irregular areas will be cored.

3. **Determination of Pavement Thickness.** Cores to determine pavement thickness shall be taken after the grinding has been done. The random core samples may or may not fall at a grinding location. At least one core will be taken at random for each pavement unit. If the initial random core is deficient in length by less than 0.2 inch from the specified pavement thickness, no additional cores will be required from that unit. When the initial random core is deficient in length by 0.2 inch and less than one inch, two additional random cores will be taken from the unit at intervals separated from each other and from the first core by at least 1/4 the length of the unit. If neither of the two additional cores are deficient in length by more than 1 inch, the average thickness of that unit of pavement will be computed as the average length of the three cores. In calculating the average pavement thickness, any core having a length in excess of the specified pavement thickness by more than 0.5 inch will be considered as having the specified length plus 0.5 inch.

When the length of any random core is less than the specified pavement thickness by more than 1 inch, exploratory cores will be taken at not less than 10-foot intervals parallel to the centerline in each direction from the random core until, in each direction, an exploratory core is obtained which is not deficient in length by more than 1 inch. The area of pavement found deficient in thickness by more than 1 inch will include the monolithic pour width of the lane or lanes and a length equal to the distance between points located mid-

way between the last two cores at each end of the deficient section. The average thickness of the remainder of the unit will be determined from at least two random cores obtained outside the area that is deficient by more than 1 inch. Exploratory cores will not be used in computing average thickness for determining adjusted unit price.

4. **Reinforcing Steel Placement.**

Vertical location of the reinforcement will be determined from the cores taken for determining pavement thickness and strength. Depth of the reinforcement below the top surface of the core will be determined from the average depth of the exposed steel members on the vertical surface of the core. Where two layers of reinforcement are evident in the core, each layer will be considered separately. All measurements will be made from the top surface of the core to the center of the exposed member, or if the member has been dislodged, to the center of the groove remaining on the vertical surface of the core.

When the average vertical location of the reinforcement in a pavement unit (as defined in Section 550.04 Q.2) is not more than 1/2 inch outside of the specified tolerance, a deduction of 10 percent of the price bid for concrete pavement in that pavement unit will be made. When the average vertical location of the reinforcement is more than 1/2 inch and less than 1 inch outside the specified tolerance, a deduction of 20 percent of the price bid for concrete pavement in that pavement unit will be made. No additional cores will be drilled for these determinations. When the average vertical location of the reinforcement is 1 inch or more outside the specified tolerance or the reinforcement is less than 2 inches from the top or bottom of the pavement slab, a determination of serviceability will be made according to Section 105.07.

R. **Operational Limits.** Operational limits shall be as specified in Section 602.03 G.

550.05 METHOD OF MEASUREMENT.

- A. **Concrete Pavement.** This item will be measured by the Square Yard according to Section 109.01. The pay quantity shall be the measured number of Square Yards of pavement complete, in place, and accepted. Separate measurement will be made of each type of concrete pavement, or high-early strength concrete pavement, for which separate payment is provided.
- B. **Portland Cement.** When separate payment is provided for Portland Cement used in concrete pavement, the cement will be measured by the Ton. The pay quantity of Portland Cement shall be the number of tons used as authorized in the concrete pavement and in integral curb or other items placed monolithically with the pavement. Cement used for items not poured monolithically with the pavement, cement used according to Section 802.01 C.2.a, and cement which is lost or wasted will not be included in the quantity measured for payment. No deduction will be made for cement used in pavement exceeding Plan thickness. The pay quantity of Portland Cement will be computed on the basis of batch weights and number of batches used as authorized, except that the pay quantity shall not exceed the total tons of cement shipped in for the Project, less any cement not measured for payment as provided above.

- C. **Pavement Reinforcement.** When separate payment is provided for reinforcement used in concrete pavement, the reinforcement will be measured as follows:
1. **Steel Fabric.** Welded Steel Wire Fabric, regardless of size or style, will be measured by the area of concrete pavement in which the fabric is incorporated, with no allowance for laps or material not used. The pay quantity of Steel Fabric will be the actual number of Square Yards of pavement in which a single layer of Steel Fabric is required or twice the actual number of Square Yards of pavement where two layers of fabric are required. No deduction in the area of fabric will be made for the required clearance adjacent to the edges of the slab and joints or for fixtures having a surface area of 9 square feet or less within the limits of the pavement. According to Section 550.04 I.5, all areas of Steel Fabric determined as not meeting the specified requirements for vertical locations will be deducted from the fabric pay quantities. Where Reinforcement Bars are permitted in lieu of Steel Fabric and no bid item is provided for the bar steel, measurement of the reinforcement will be made on the basis that the Steel Fabric is used.
 2. **Reinforcement Bars.** Bar Steel Reinforcement for concrete pavement (not including dowels, tie bars, or supporting devices) will be measured by the Pound, based on the theoretical weights of bars as listed in Section 612.04, and with no allowance for laps. When Reinforcement Bars of greater section area than required are permitted and used, measurement will be based on bar sizes specified. According to Section 550.04 I.5, the weight of all Bar Reinforcement determined as not meeting specified requirements for vertical location will be deducted from the pay quantities of the reinforcement. Where Steel Fabric is permitted in lieu of Reinforcement Bars and no bid item is provided for the Steel Fabric, measurement will be made on the basis that bar reinforcement is used.
- D. **Doweled Joint Assemblies.** When separate payment is made for Doweled Expansion or Contraction Joint Assemblies, the joint assemblies will be measured by the Linear Foot. The pay length will be equal to the width of pavement in which the joint assembly is installed. When separate payment is not made for Doweled Expansion or Contractor Joint Assemblies, the cost to provide and install the assemblies shall be included in the bid item "Concrete Pavement."
- E. **Integral Curb.** When separate payment is made for Integral Curb, measurement of the curb will be based on horizontal dimensions. The pay quantity shall be the Linear Feet of Integral Curb in place.
- F. **Preformed Elastomeric Compression Joint Seal.** Preformed Elastomeric Compression Joint Seal will be measured by the Linear Foot of joint in which the seal is installed.
- G. **Longitudinal Shoulder Joints.** This joint will be measured by the Linear Foot of completed joint.
- H. **Fly Ash.** Fly Ash will be measured as provided for Portland Cement.
- I. **Sawing and Sealing Joints.** On projects where a separate bid item for sawing and sealing of joints is not included in the Plans, the work will not be measured separately but shall be included in the price bid for other items.

550.06 BASIS OF PAYMENT.

- A. **Concrete Pavement.** The accepted quantities of concrete pavement will be paid for at the Contract Unit Price bid per Square Yard, except any pavement found deficient in thickness by more than 0.2 inch but not more than one inch when determined according to Section 550.04 Q will be paid for at an adjusted unit price as specified in the following table:

Deficiency in Pavement Thickness (Inches)	Deduction of Contract Unit Price
0 to 0.2	0%
Over 0.2 to 0.3	10%
Over 0.3 to 0.5	20%
Over 0.5 to 0.6	30%
Over 0.6 to 0.7	40%
Over 0.7 to 1.0	50%

If cement, flyash, aggregates, or other concrete components are bid separately, their costs will be added to the Contract Unit Price per Square Yard of concrete pavement before calculating the price deductions for the pavement deficient in thickness.

When the pavement thickness is deficient by more than 1 inch, and the Engineer determines the deficient area should not be removed and replaced, based on structural and serviceability criteria, there will be no payment for the area retained. No payment exceeding the Contract Unit Price will be made for any pavement which has an average thickness in excess of that specified.

The payment for concrete pavement or high early strength concrete pavement shall include all work and items involved in construction of pavement such as Portland Cement, fly ash, steel reinforcement, tie bars, joint sealants, curing materials, etc. Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
__IN Non-Reinforced Concrete Pavement CI__	Square Yard
__INNon-Reinforced Concrete Pavement CI. AE - Doweled Reinforced Concrete Pavement	Square Yard
Non-Reinforced Concrete Pavement CI__ High Early Strength	Square Yard
Reinforced Concrete Pavement CI__ High Early Strength	Square Yard
Continuously Reinforced Concrete Pavement	Square Yard

- B. **Miscellaneous Items.** When shown on the Plans, payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Portland Cement, Type ____	Ton or Cwt.
Fly Ash	Ton
Reinforcement - Steel Fabric	Square Yard
Reinforcement - Steel Bars	Pound
Doweled Expansion Joint Assembly	Linear Foot
Doweled Contraction Joint Assembly	Linear Foot

Integral Curb	Linear Foot
Preformed Elastomeric Compression Joint Seal	Linear Foot
Longitudinal Shoulder Joint	Linear Foot
Continuous Rumble Strip	Mile
Grinding New PCC Pavement	Square Yard

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

**SECTION 560
RECYCLED PORTLAND CEMENT CONCRETE
PAVEMENT**

560.01 DESCRIPTION.

This work consists of removing, crushing, screening, and stockpiling Portland Cement Concrete pavement into the required gradation, and adding new materials to produce and place a Portland Cement Concrete pavement. Section 550 will be applied in conjunction with this Section.

560.02 MATERIALS.

Materials shall meet Sections 550 and 802.

Class AE Portland Cement Concrete pavement shall consist of processed salvaged concrete, new coarse aggregate, new fine aggregate, water, an air entraining agent, and Type I, IA, or II Portland Cement.

560.03 EQUIPMENT.

Equipment shall meet the following:

Item	Section
General	151.01
P.C.C. Equipment	153

560.04 CONSTRUCTION REQUIREMENTS.

- A. **Prepare Stockpile Sites.** The Contractor shall remove and stockpile all available topsoil, up to a maximum of 1 foot. The site shall be shaped and compacted so water drains away from the salvaged concrete stockpile. The Contractor shall furnish, place, compact, and shape to drain a 6-inch depth of granular material, with less than 30 percent pass the No. 200 sieve over the stockpile site.
- B. **Stockpiling.** The salvaged material shall be stockpiled according to Section 106.06. Each stockpile shall be located to facilitate future processing and access to the material without interference by other stockpiles.

All stockpiled salvaged concrete material remaining at the completion of the Project shall be the property of the Department.

- C. **Restore Stockpile Site.** The Contractor shall restore the stockpile site upon completion of the Project. The unused or waste concrete material and aggregate bedding shall be disposed of at locations acceptable to the Engineer. The stockpile site shall be lightly scarified and shaped to drain. The topsoil shall be spread uniformly over the site. The site shall be seeded and fertilized with the class of seed specified.
- D. **Removing Concrete Pavement.** The earthen inslopes shall be bladed away from the shoulder surfacing before removing any surfacing. When the surfacing is replaced and completed, the earthen inslopes shall be restored to form a smooth uniform inslope free of clumps of dirt, sod, rocks, etc.

Construction operations shall be conducted without damaging existing signs, culverts, guardrail, and roadway appurtenances. Damaged items shall be replaced by and at the Contractor's expense.

Bituminous shoulders adjacent to the concrete pavement shall be removed before removing the concrete pavement. This material shall be removed from the roadway and hauled to a stockpile site in conformance with specified requirements.

Before removing the pavement, all bituminous patching material and joint material shall be removed and disposed of by the Contractor at locations acceptable to the Engineer.

The pavement shall be removed with equipment and methods that do not contaminate the removed material with dirt, aggregate, and other foreign material. Removal equipment or methods that damage culverts under the roadbed shall not be permitted. Damaged culverts shall be replaced by and at the Contractor's expense. The removed pavement shall be loaded and hauled to the prepared stockpile site and stockpiled as specified.

- E. **Existing Reinforcing Steel.** The reinforcing steel removed from the existing Portland Cement Concrete pavement shall become the property of the Contractor and be removed from the highway Right of Way upon completion of the Project.
- F. **Processing Salvaged Concrete.** The removed concrete shall be crushed to the maximum size specified. It shall be of such gradation that when combined with the virgin aggregate, the total coarse aggregate meets the gradation requirements of Size 4 concrete aggregate of Section 816.02 A, including material passing the No. 200 sieve.

Crushing operations shall be adjusted to maximize the amount of crushed material retained on the No. 8 sieve, while still maintaining the Size 4 aggregate gradation. All reinforcing bars, mesh, dowel bars, dowel bar assemblies, joint filler, bituminous material, and other foreign material shall be removed from this material. Foreign material shall be disposed of at locations acceptable to the Engineer. Any equipment and method to remove foreign material may be used that produces results acceptable to the Engineer.

A spray bar shall be installed at the end of the crushing operation to prewet the salvaged coarse aggregate before it is placed in the stockpile. All coarse aggregate

stockpiles shall be prewatered to the extent that it is above a saturated surface dry condition at the time of incorporation into the mix. All costs to achieve this moisture condition shall be included in other items of work.

- G. **Mixing.** The processed, salvaged concrete shall be mixed in the plant according to Section 802 for a Class AE mixture. The coarse aggregate in the concrete mixture shall consist of a minimum of 20 percent coarse virgin aggregate. The salvaged aggregate and virgin aggregate shall be blended in the plant.

The percentage of new fine aggregate may require adjustment to achieve a workable mix.

- H. **Placing.** The concrete mixtures shall be placed according to Section 550.
- I. **Pavement Surface Riding Quality.** Riding quality and pay adjustment will be as specified in Section 550.04 P.2.
- J. **Determination of Pavement Thickness.** Pavement thickness will be determined as specified in Section 550.04 Q.3.

560.05 METHOD OF MEASUREMENT.

- A. **Prepare Stockpile Site.** Prepare Stockpile Site will be measured as a completed and accepted unit item to be bid as a "Lump Sum." The Lump Sum shall be considered payment for removing and stockpiling topsoil; shaping and compacting subgrade; furnishing, placing, shaping, and compacting granular material; all labor, equipment, and materials required for the stockpile site(s).

All virgin P.C.C. pavement aggregate and salvaged bituminous material stockpiled at the plant site shall be considered the property of the Contractor. Payment will not be made for salvaged material which is stockpiled and not incorporated into the Project.

- B. **Restored Stockpile Site.** Restore stockpile site will be measured as a completed and accepted unit item to be bid as a "Lump sum." The Lump Sum payment will be considered full payment for all disposal of wastes, spreading topsoil, compaction, blading, water, seed, fertilizer, labor, equipment, and material required to complete the item.
- C. **Removal of Concrete Pavement.** Removal of Concrete Pavement will be measured by the Square Yard of material removed from the roadway.
- D. **Recycled Concrete Pavement.** All concrete pavement produced shall be paid for at the unit price bid for Recycled Concrete Pavement even after all sources of salvaged coarse aggregate have been exhausted.
- E. **Coarse Aggregate Size 4.** Coarse Aggregate Size 4 will be measured by the ton, based on the saturated surface dry weight, of material used as specified. The weight of Size 4 shall be determined from the mix design weight of the aggregate multiplied by the number of batches produced minus any waste.
- F. **Fine Aggregate.** Fine Aggregate will be measured by the Ton, based on the saturated surface dry weight, of material used as specified. The weight shall be deter-

mined from the mix design weight of the aggregate multiplied by the number of batches produced minus any waste.

560.06 BASIS OF PAYMENT.

- A. **Recycled Concrete Pavement.** The accepted quantities of Recycled Concrete Pavement will be paid according to Section 550.06 and the following:

Pay Item	Pay Unit
Nonreinforced Recycled Pavement	Square Yard
Prepare Stockpile Site	Lump Sum
Restore Stockpile Site	Lump Sum
Removal of Concrete Pavement	Square Yard
Coarse Aggregate, Size 4	Ton
Fine Aggregate	Ton

If the bid items “Fine Aggregate” and “Coarse Aggregate, Size 4” are not included as pay items in the Contract, payment for these items will be included in the price bid for “Nonreinforced Recycled Concrete Pavement.”

- B. **Miscellaneous Items.** When shown on the Plans, payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Portland Cement, Type _____	Ton
Fly Ash	Ton
Steel Fabric, _____	Square Yard
Reinforcement Bars	Pound
Doweled Expansion Joint Assembly	Linear Foot
Doweled Contraction Joint Assembly	Linear Foot
Integral Curb	Linear Foot
Preformed Elastomeric Compression Joint Seal	Linear Foot
Longitudinal Shoulder Joint	Linear Foot

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

SECTION 570 PORTLAND CEMENT CONCRETE PAVEMENT REPAIR

570.01 DESCRIPTION.

This work consists of removing portions of existing Portland cement concrete pavements and adding new materials to produce a new Portland cement concrete pavement

repair. This work may also include dowel bar retro-fits and grinding to restore the ride to an existing Portland cement concrete pavement. Section 550 will be applied in conjunction with this section.

570.02 MATERIALS.

A. **General.** Materials shall meet the following:

Item	Section
Portland cement concrete	802
Grouts and mortar	806
Reinforcing steel	836
Dowel bars	836

B. **Portland Cement Concrete for Repairs.** Use a 6.5 bag mix of Type I cement with a maximum water content of 5.1 gal/bag of cement for full depth repairs. Use AASHTO M-85 high early cement for spall repairs. The concrete shall be air-entrained.

C. **Joint Materials.**

1. **Concrete Joint Sealer.** The joint sealer shall be as shown on the plans unless an alternate type is approved by the Engineer before use.
2. **Fillers and Sealant.** Materials shall meet the following:

Item	Section
Preformed expansion joint filler	826.02 C
Preformed expansion joint filler (Bituminous Type)	826.02 D
Preformed elastomeric compression joint seal	826.02 G
Hot-pour joint sealant	826.02
Silicone joint sealant	826.02 B
Backer rod	826.02 B.1

D. **Dowel Bar Retrofit.**

1. **Curing Compound.** The curing compound shall be a wax-based liquid membrane-forming compound that conforms to the requirements of AASHTO M 148 (ASTM C 309) Type 1-D or 2, Class A or B.
2. **Dowel Bars.** The dowel bars shall be plain, round bars fabricated from steel meeting AASHTO M 31, M 42, or M 53. Dowel bars shall be cut to the required length and cleaned to remove all cutting burrs, loose mill scale, rust, grease, and oil. The bars may be sheared providing the deformation of the bars from true round shape does not exceed 0.04 inch in diameter or thickness, and shall not extend more than 0.04 inch from the sheared end.

Dowel bars shall be epoxy-coated 100 percent on all surfaces. The epoxy coating shall be in accordance with AASHTO M 284. The dowel bars shall also be shop coated with a bond breaking release agent. The bond breaking release agent shall be a curing compound meeting the requirements specified above.

The dowel bars shall have tight fitting end caps made of nonmetallic materials that allow for 1/4 inch movement of the bar at each end. The Contractor shall submit sample end caps to the Engineer prior to use.

3. **Caulk.** The caulk for sealing the existing transverse joint crack at the bottom and sides of the slot shall be any commercial caulk designed as a concrete sealant that is compatible with the patch material being used.
 4. **Foam Core Board.** The foam core board shall be constructed of closed cell foam and be faced with poster board material or laminate on each side.
 5. **Patching Material.** "Concrete Patch Mix" shall be Five Star Highway Patch, Burke 928 Fast Patch, American Highway Technology's (AHT) dowel bar retrofit mortar or an approved equal. The concrete patch mix shall be mixed and placed according to the manufacturer's recommendations.
 6. **Chairs.** The chairs for supporting and holding the dowel bars in place shall be completely epoxy-coated according to Section 836.02 B, or made of nonmetallic material.
 7. **Concrete Mix Design.** The Contractor shall provide the Department with a concrete mix design for the patching material that meets a minimum compressive strength of 4,000 psi in six hours, prior to the beginning of work. this mix design shall include all additives and materials that will be used on the Project.
- E. **Joint Stitching.** This work consists of placing epoxy coated deformed bars into existing concrete pavement.
1. **Epoxy.** The epoxy resin shall be of the type intended for horizontal application and shall meet requirements of AASHTO M 235, Type 1, Grade 3. The Contractor shall mix epoxy resin as recommended by the manufacturer.
 2. **Tie Bars.** The tie bars shall be Grade 60 and epoxy-coated according to AASHTO M 284.

570.03 EQUIPMENT.

Equipment shall meet the following:

Item	Section
General	151.01
PCC equipment	153

570.04 CONSTRUCTION REQUIREMENTS.

- A. **General.** The notes in this section (570.04 A) apply to repairs made to non-reinforced jointed PCC pavements and to continuously reinforced PCC pavements.
1. **Restoring the Subgrade.** Concrete in full depth repair areas shall be removed by lifting with adequately sized equipment that will minimize disrup-

tion to the existing subgrade. Construction equipment will not be allowed in areas where the concrete has been removed. Voids deeper than one inch beneath the removed concrete shall be filled and compacted with granular fill as directed by the Engineer.

Any over-depth removal not authorized by the Engineer shall be replaced and compacted with Class 5 aggregate as approved by the Engineer. The cost for any unauthorized over-depth removal and Class 5 subsequently required shall be at the Contractor's expense.

2. **Forms for PCC Repairs.** The Contractor shall use forms on all exposed edges and steel forms for full-depth repairs longer than 15 feet longitudinally and continuous full-depth forms of steel or 2-inch thick lumber for repairs less than 15 feet longitudinally. All forms shall be placed according to Section 550.04 G.2.
3. **Damaged Areas.** Areas damaged during curing, spalling at full-depth repair edges when traffic is allowed on repair areas after sawcutting and before pavement removal shall be repaired at the Contractor's expense.
4. **Reinforcing Steel.** Include all costs for steel reinforcing, bar supports, and tie bars in the unit price bid for full-depth repairs.
5. **Spall Repair.** Outline the spall to be repaired using a minimum 3-inch depth sawcut. Keep sawcuts beyond the patch outline to a minimum and seal them with a non-shrinking mortar material. Remove loose or unsound concrete within the outlined area (2 feet × 2 feet minimum dimensions) down at least 3 inches to sound concrete using 15-pound chipping hammers (space or other wide flat bit) and hand tools. Cut off and remove reinforcing bars discovered during the removal process. Place a form to match the patch edge to the pavement edge where the patch extends to the pavement edge.

Sandblast the patch area. Remove all loose particles with air under pressure, directing the material away from traffic lanes. Paint the cleaned surface with an even coat of grout, placing the concrete before the grout whitens. Sandblast and regrout the patch area if any whitening occurs. Form a stiff slurry with equal parts by weight of Portland cement and fine aggregate mixed with water and apply with a stiff brush to the old concrete in a thin, even coating that does not run or puddle.

Change the repair to full-depth if in removing the existing pavement for spall repair the engineer determines the extent of damage requires a full-depth repair. Measure the final repair limits for full payment as full-depth repair, plus measure the original repair limits for one-half the bid price for spall repair.

Pour spall repairs when air temperatures are above 40°F.

6. **Repair Size and Longitudinal Joint Treatment.** Place no full-depth repairs less than six feet longitudinally. Place repairs less than full panel length, using a full-depth centerline bond breaker (such as a thickness of bituthene) and no centerline steel tie. Restore the longitudinal joint but not the tie bars between the mainline and a ramp or ramp taper when the repair falls in the area of a ramp.

Replace full-depth repairs involving both lanes, using the following centerline treatments:

- a. Fill the centerline gap between the first pour and the existing concrete with cold bituminous material to prevent water infiltration. Remove this material before the second pour. Include all costs to provide, place, and remove this material in the price bid for the full-depth repair.
 - b. Treat centerline joint steel on repairs exceeding 15 feet in length as follows:
 - (1) Expose each half of existing bars independently and re-pour to leave the existing bar in its original location or,
 - (2) Install new #5 × 2 feet 6 inch tie bars in the joint before placing the second pour to establish the original tie bar pattern and steel cross-sectional area. Install tie bars by drilling and grouting with a high-viscosity epoxy, meeting the requirements of AASHTO M 235, Class 3. The price bid for full-depth repair shall include the costs for all material, equipment, and labor required to make the repairs, as specified above.
7. **Placing Portland Cement Concrete.** Full-depth repairs 100 feet and shorter in longitudinal dimension shall be placed the same day the concrete removal is initiated. Repairs longer than 100 feet shall be placed within 48 hours of the initiation of concrete removal.

Place, consolidate, finish, and cure the concrete according to Section 550 of the Specifications. Wet the faces of old concrete around the repair with water before placing the new concrete.

Finish full-depth repairs longer than 15 feet longitudinally with a mechanical screed capable of providing finish and ride requirements according to Section 550 with limited handwork. Finish concrete flush with adjacent pavement surface. Straight edge to ensure a smooth riding surface and texture longitudinally with a carpet-type artificial grass drag. Check with a 10-foot straightedge before the concrete has set and correct spots 1/8 inch high or low. Correct areas not meeting surface tolerance according to Section 550.04 P.1.

8. **Longitudinal Joint Sealing.**

The Contractor shall shape the longitudinal joint reservoir 1/4-inch wide by 3/4-inch deep in areas of full depth repairs. The joints shall be cleaned as directed by the Engineer. The sealant shall be a Type 2 Hot Applied Joint Sealant.

B. Non-Reinforced Jointed PCC Pavement Repairs.

1. **Existing Non-Reinforced, Jointed PCC Pavement Removal.** Saw the perimeter of the repair full depth with a diamond or carborundum blade. Make the final full-depth cut immediately after the partial-depth cuts when using more than one pass. Make transverse sawcuts parallel to existing transverse

joints when fixed joints are not used on the repair. Extend transverse sawcuts (only far enough into concrete to remain) to guarantee a full-depth cut of the repair area, and seal the cut with a non-shrinking mortar material. Remove concrete by the lift-out method within 48 hours of the transverse sawing. Prepare repair edges reasonably free of the frays or spalls. Make intermediate cuts with other types of saws without penetrating the subgrade to facilitate removal.

2. **Work Sequence.** Use the following work sequence after removing the existing PCC pavement:
 - a. Perform subgrade repair, full-depth concrete pavement repair, and partial-depth spall repair simultaneously.
 - b. Retrofit dowel bars, if called for on the Plans.
 - c. Perform stitching, if called for on the Plans.
 - d. Grind 12-foot driving lane, 3-foot transition in passing lane, and 3-foot transition in outside shoulder, if called for on the Plans. Grind transitions after the adjacent portion of the driving lane has been ground.
 - e. Clean and seal random cracks and transverse joints. Clean and seal longitudinal centerline and 10-foot shoulder joints.

3. **Bars for Transverse Joint at Full-Depth Repairs (Load Transfer).** Drill one 3/8-inch maximum diameter holes at mid-depth of slab spaced as shown using rigid frame-mounted drills for proper position and alignment. Brush holes with a stiff nylon brush and blow clean with compressed air to the back of the hole. Inject a high-viscosity epoxy (meeting AASHTO M 235 Class III) into the back of the hole with a pressurized caulking apparatus. Insert 1-1/4 inches × 18 inches smooth dowel or #9 × 18 inches deformed Grade 40 bars, as detailed, twisting 180 degrees to 360 degrees to allow air to escape and ensure completely filled holes with bars permanently fastened to the existing concrete. Apply small form to face of hole to keep epoxy from flowing out and remove it prior to placing concrete.

Align smooth dowel bars with the pavement direction and parallel to the plane of the surface. Lightly coat the end of each smooth dowel, extending into the patch with grease, according to Section 550.04 I.2.

4. **Transverse Joint Sealing at Full-Depth Repairs.** Seal smooth doweled transverse joints at full-depth repairs according to Section 550.04 M, allowing traffic on the new pavement from the end of the curing period to the beginning of the joint sealing.

Seal fixed transverse joints at full-depth repairs with Type I hot poured elastic-type joint sealant, according to Section 550.04 M. Shape the reservoir to 1/4 to 3/8-inch wide by 1 inch deep, clean as directed by the Engineer, and seal.

- C. **Dowel Bar Retrofit.** This work consists of retrofitting epoxy-coated bars into existing concrete pavement.

Prior to construction, the Contractor shall provide the Engineer with the manufacturer's product literature for usage of the patch mix.

The Contractor shall install the dowel bars in the existing concrete pavement as shown in the plans and according to the following specifications:

1. **Sawing.** Slots shall be cut in the pavement with a gang saw capable of cutting a minimum of three slots in the wheel path, at a time. The slots shall be cut to the depth required to place the center of the dowel at mid-depth in the concrete slab. Multiple saw cuts parallel to the centerline may be required to properly remove material from the slot.
2. **Jack Hammers.** Jack hammers used to remove the concrete shall not be larger than the 30-pound class.
3. **Cleaning.** All exposed surfaces and cracks in the slot shall be sandblasted and cleaned of saw slurry and loose material before installing the dowel. All loose material will be disposed of by the Contractor off of the highway Right of Way.
4. **Dowel Bar Chair Placement.** Dowel bars shall be placed in a chair that will provide a minimum of 1/4-inch clearance between the bottom of the dowel and the bottom of the slot. The dowel bar shall be placed to the depth shown in the plans, parallel to the centerline, and parallel to pavement surface of the lower panel at the transverse joint, all to a tolerance of 1/4 inch. The chair design shall hold the dowel bar securely in place during the placement of the patch mix.
5. **Joint Caulking.** Caulk the existing transverse joint crack at the bottom and sides of the slot as shown in the Plans. The transverse joint crack shall be caulked to provide a tight fit for the foam core board at the transverse joint and to prevent any of the patch mix from entering the crack at the bottom or the sides of the slot. The sealant shall not extend beyond 3/8 inch of each side of the existing transverse joint crack.
6. **Dowel Bar Placement.** The dowel bar shall be placed through the foam core board at the specified location. The dowel bar shall be placed so a minimum of 7 inches is placed on either side of the transverse joint. The foam core board shall be capable of remaining in a vertical position and tight to all edges during the placement of the patch mix. If for any reason the foam core board shifts during the placement of the patch mix, the work shall be rejected and replaced at the Contractor's expense.
7. **Mixing Patch Material.** The patch material shall be mixed with a hand mixer. A metering or measuring device for the water is required. The Contractor shall assure that a consistent batch of patch mix is being produced. A mobile mixer is not acceptable.

The patching material will be tested by the Engineer at a rate of one test for each four hours of production. A minimum compressive strength of 4,000 psi in 6 hours is required. If compressive strengths are not being met, production shall cease and the Contractor shall resubmit a mix design correcting the strength problems.

8. **Existing Concrete Surface Preparation.** The existing concrete surfaces inside the slotted area shall be moistened with water, using a hand sprayer immediately prior to placing the patch mix.
 9. **Placing Patch Mix.** The patch mix shall be placed into the slot and vibrated with a small hand-held vibrator to ensure that the patch mix completely surrounds the dowel bar.
 10. **Curing.** The surface of the patched area shall be flushed with a curing compound that meets the requirements of AASHTO M 148 (ASTM C 309) Type 1-D or 2, Class A or B. The curing compound shall be applied within 30 seconds after a set of three dowel bar patches have been finished.
 11. **Spall Repairs.** Any spalling that occurs to the transverse joints shall be repaired at the Contractor's expense. The joint shall be sawed and sealed as shown in the plans.
 12. **Opening to Traffic.** The dowel bar retrofit portion of the project will not be opened to traffic until the surface has been ground.
 13. **Grinding.** Grinding of pavements and dowel bar retrofit slots shall wait a period of 24 hours or until the next working day.
- D. **Joint Stitching.** The Contractor shall install the tie bars in the existing pavement alternately from opposite sides of the joint or crack to produce a cross-stitching pattern.

The type, size, and length of the tie bars shall be shown in the Plans. The location, angle size, and depth of the holes shall be as shown in the Plans. The minimum depth of cover from the pavement surface to the tie bar shall be as shown in the Plans. No bars shall be installed within 9 inches of an existing transverse contraction joint. Tie bars shall be installed the same day the holes are drilled.

1. **Drilling.** The drills used for making the holes shall be hydraulic percussive type and shall be mounted on a ridged frame to provide proper position and alignment. The Contractor shall exercise care in drilling holes for the placement of the tie bars. Damage to any pavement shall be repaired to the satisfaction of the Engineer at the Contractor's expense.
2. **Cleaning.** Prior to injecting epoxy resin, the drilled holes shall be blown clean with compressed air using a device that will reach the bottom of the hole to ensure that all debris or loose material has been removed.
3. **Epoxy.** The epoxy shall be injected in the bottom of the hole with a pressurized caulking apparatus which allows air to escape and the epoxy to flow up toward the pavement surface as the tie bar is inserted. The holes shall be filled with epoxy prior to insertion of the tie bar so that the epoxy will be level with the top of the pavement after bar insertion.
4. **Tie Bars.** the tie bars shall be placed so that there is an equal length of bar embedded in the adjacent sides of the joint or crack without protruding through the bottom of the slab. The tie bars shall be rotated 180 degrees to 360 degrees during the insertion to eliminate voids and to ensure complete

bonding of the bar. The top shall be filled or cut to level the epoxy with the existing pavement.

- E. **Grinding.** This work consists of grinding existing PCC pavement to provide a skid resistant surface to meet smoothness requirements.
1. **Equipment.** Grinding equipment shall conform to Section 153.15.
 2. **Construction Requirements.** The entire pavement surface area specified shall be ground and textured until the surface of both sides of the transverse joints and cracks are in the same plane and meet the smoothness required. Misalignment of the planes of the surfaces on the adjacent sides of the joint or crack, which are in excess of 1/16 inch, shall be ground until the surfaces are flush. The finished texture shall be uniform.
 - a. **Grinding Depth.** Extra depth grinding to eliminate minor depressions in order to provide texturing of all pavement surface is not required. A minimum removal of 1/16 of an inch is required at all locations except at culverts, dips, or similar conditions. Exceptions shall be made by the Engineer in the field. However, it is the intent of this specification that nearly 100 percent of the area specified is to be textured.
 - b. **Grinding Direction.** Grinding shall be performed in a longitudinal direction. Grinding shall begin and end at lines normal to the pavement centerline within any one ground area. The area ground shall not be left smooth or polished.
 - c. **Texture.** Grinding shall result in a parallel corduroy-type texture consisting of grooves between 0.090 and 0.130 inches wide. The distance between grooves shall be between 0.060 and 0.125 inches. The peaks of the ridges shall be approximately 1/16 of an inch higher than the bottom of the grooves. Adequate cross slope drainage shall be maintained.
 - d. **Transitions.** Auxiliary or ramp lane grinding shall transition as required from the mainline edge to provide positive drainage and an acceptable riding surface.
 - e. **Slope.** The transverse slope of the pavement shall be uniform to the degree that no depressions or misalignment of slope greater than 1/4 inch in 10 feet exists when tested with a 10-foot straightedge. Straightedge requirements do not apply across longitudinal joints or outside ground areas.
 - f. **Clean-Up.** The pavement shall be left in a clean condition. The removal of all slurry or residue resulting from the grinding operation shall be continuous. The Contractor shall control the grinding operation so the residue from the operation does not flow across lanes used by traffic.
 3. **Ride Quality.**
 - a. **Equipment.** The Contractor shall furnish and operate an approved 25-foot, California-style profilograph. The profilograph shall consist of a 25-foot frame, supported upon a multiple system of wheels at both

ends. The profile shall be recorded from the vertical movement of a wheel, attached to the frame at midpoint in reference to the mean elevation of the points of contact established by the support wheels. The profilogram shall be recorded on a scale of one inch equal to 25 feet longitudinally and 1 inch vertically.

- b. **Calibration.** Prior to pavement grinding on the project and periodically thereafter, the calibration of the profilograph shall be checked by the Contractor in the presence of the Engineer. The horizontal scale can be checked by running the profilograph over a known distance and scaling the results on the profilogram. The cause of incorrect scales shall be determined and corrected prior to using the profilograph.
- c. **Operation.** The profilograph shall be operated at a speed no greater than a normal walk. Two passes shall be made in the ground lane, one in each approximate wheel path. The test wheel shall be lifted and the profilogram clearly labeled to mark the beginning and end of each trace, equations, and 500-foot markers. Each trace shall be completely labeled to show the project, stationing, lane, wheel path, date ground, date tested, and operator's name. Each tracing shall be furnished to the agency personnel prior to moving on to the next phase of work in the test area. All area(s) that need to be reground will be retested and have the retest results fastened to the original tracing.
- d. **Evaluation.** After completion of grinding and texturing, the pavement surface shall have an average profile index of 0.3 inches or less in each 0.1 mile section. Individual bumps in excess of 0.3 inches in 25 feet, as measured by the profilograph, will be ground as directed by the Engineer. Evaluation consists of determining the profile index to the nearest 0.5 inches/mile by measuring and summing scallops that appear above and below a 0.2-inch blanking band. The average profile index will be determined from the two wheel paths in the ground lane.

The following areas of pavement will be exempt from the 0.3 inches in each 0.1 mile segment. 1) Pavement on horizontal curves having a centerline radius of curve less than 1,000 feet and pavement within the super elevation transition of such curves. 2) Pavement within 50 feet of the end of the project. 3) Pavement for ramps, acceleration and deceleration lanes, approaches, structure decks, city streets or county roads. 4) Pavement within 50 feet of a transverse joint that separates the pavement from a structure deck or an approach slab.

The Department will spot check or retest areas it desires, with their own profilograph. If a discrepancy between the profilograms exist, the cause of the discrepancy shall be determined and the area re-run if necessary, as determined by the Engineer.

Pay Item	Pay Unit
PCC Pavement Grinding	Square Yard

4. **Joints.**

- a. **One-Half Inch Transverse PCC Joint Cleaning and Sealing.** Joints to be cleaned and resealed shall be done so in accordance with Section

550.04 M. Clean and reseal the portion of the transverse joint ground. Remove existing sealant without damaging that to remain.

- b. **Longitudinal PCC Joint Cleaning and Sealing.** Remove existing hot pour, sandblast, and blow the joint clean, and fill with Type I hot pour.

F. Continuously Reinforced PCC Pavement Repairs.

1. **Existing Concrete Removal.** Saw the repair area edges with a diamond or carborundum blade as shown in the plans, leaving the edges reasonably free of frays or spalls at the pavement surface.

Use 35-pound or smaller air hammers to avoid damage to reinforcing steel within the 18-inch lap areas and to avoid spalling at the bottom of the joint (beneath the partial-depth sawcut). Do not bend reinforcing steel which is to remain in place. Use a concrete cutter 24 inches from the partial-depth sawcut to facilitate removal. Break large areas, using a heavy ball, drop hammer, hydro-hammer, or other heavy equipment. First break a full-depth, two-foot strip along the sawcut or sawcut line with a concrete cutter, hand tools, or equipment no larger than a 35-pound air hammer. Use no heavy equipment adjacent to concrete in place less than 48 hours. Remove from the roadway and dispose of all the material off the Right of Way at the end of each day.

2. **Full-Width, Full-Depth Repairs.** Place the first lane at locations where both lanes are to be repaired in the following manner:
 - a. Connect longitudinal rebars with mechanical splices, meeting the American Concrete Institute (ACI) Building Code for Reinforced Concrete (Chapter 12.14.3.4).
 - b. Use Class AE high-early concrete with a Type A additive designed to attain 3,000 psi compressive strength within 24 hours.
 - c. Place Portland cement concrete between 4 p.m. and 8 p.m. with rebar connections not fully tied until within 20 minutes prior to the pour.

570.05 METHOD OF MEASUREMENT.

- A. **Spall Repair.** Measure and pay for spall repair by the square foot of repair area specified and accepted by the Engineer. Include all costs for work performed, labor, and materials.
- B. **Longitudinal PCC Joint Cleaning and Sealing.** Include all costs for material and labor for forming or sawing, cleaning, and sealing longitudinal joints in the unit price bid for "Longitudinal PCC Joint Cleaning and Sealing."
- C. **Full-Depth Repair Items.** Include all costs for removing, hauling, and disposing of concrete and any material sticking to the removed concrete in the unit price bid for "Full-Depth Repair Items."
- D. **Dowel Bars.** Include all costs for work, labor, and materials to install the smooth or deformed bars, as described above, in the unit price bid for "Dowel Bars."
- E. **1/2-Inch Transverse PCC Joint Clean and Sealing.** Include all costs to form, clean, and seal smooth doweled joints in the unit price bid for "1/2-Inch Transverse PCC Joint Clean and Sealing."

- F. **__Inch Concrete Pavement Repair (Full-Depth - Doweled).** Include all costs to form, clean, and seal fixed joints in the unit priced bid for “__Inch Concrete Pavement Repair (Full-Depth - Doweled).”
- G. **Sawcuts.** Sawcuts will be measured by the linear foot. Measure sawcuts around the perimeter of full-depth jointed pavement repairs for payment. Include the costs for all other sawcuts in the bid item for the work being performed.
- H. **Full-Depth Repairs.** Measure full-depth concrete pavement repairs by the square yard of the area specified and accepted by the Engineer. Pay for the full-depth repair quantity at the contract unit price bid.
- I. **Dowel Bar Retrofit.** Installation of the dowel bars will be measured and paid for as “Dowel Bar Retrofit Type B” for each dowel bar installed and accepted by the Engineer. Payment shall be full compensation for all labor, equipment, and material necessary to complete the work, as specified.
- J. **Joint Stitching.** Installation of tie bars will be measured and paid for as “Epoxy-Coated Deformed Bars” for each tie bar installed and accepted by the Engineer. Any bars that are damaged or not functioning shall be replaced at the expense of the Contractor. Payment shall be full compensation for all labor, equipment, and materials necessary to complete the work, as specified.
- K. **Grinding.** Grinding will be measured per square yard of pavement ground and accepted by the Engineer. Payment for grinding shall be full compensation for all labor and equipment necessary to complete the work.
- L. **One-Half Inch Transverse PCC Joint Cleaning and Sealing.** Measure the joints cleaned and sealed by the linear foot. Regardless of joint width, include all costs for work, including sawing and backer rod when required, in the unit price bid for “1/2-Inch Transverse PCC Joint Cleaning and Sealing,” “Longitudinal PCC Joint Cleaning and Sealing,” and “Random PCC Crack Cleaning and Sealing.”
- M. **Longitudinal PCC Joint Cleaning and Sealing.** Include all costs for extra work and materials to fill varying joint widths and depths in the unit price bid for “Longitudinal PCC Joint Cleaning and Sealing.”
- N. **Full-Depth Repair - End Preparation.** Include all costs for sawing, concrete removal, and preparation of reinforcing steel within each 2-foot end of the full lane width, full-depth repair in the unit price bid price for “Full-Depth Repair - End Preparation.” Include all costs of removing, hauling, and disposing of the rest of the removed concrete in the unit price bid for full-depth repair items.
- O. **Full-Depth Repair - End Prep-Mech Splice.** Include all costs for sawing, concrete removal, reinforcing steel preparation, and mechanical splice rebar connections within each 2-foot end of the full-depth repair (full lane width) in the unit price bid for “Full-Depth Repair - End Prep-Mech Splice.”
- P. **Full-Depth Continuous Concrete Repair.** Full-Depth continuous reinforced concrete repair shall be measured and paid for by the square yard of area specified and accepted by the Engineer at the contract unit price bid. Additional repair area

and additional end preparation for Engineer-approved extension of full-depth repairs will be measured and paid for.

570.06 BASIS OF PAYMENT SUMMARY.

Pay Item	Pay Unit
PCC Pavement Grinding	SY
Doweled Contraction Joint Assembly	LF
Dowel Bars	EA
Dowel Bar Retrofit - Type BEA	
Full-Depth Repair - End Prep - Mech Spine	EA
Full-Depth Repair - End Preparation	EA
___-Inch Concrete Pavement Repair - Full-Depth Doweled	SY
___-Inch Concrete Pavement Repair - Full-Depth Continuous	SY
1/2-Inch Transverse PCC Joint Cleaning & Sealing	LF
Contraction Joint Silicone Seal	LF
Longitudinal PCC Joint Cleaning & Sealing	LF
Random PCC Crack Cleaning & Sealing	LF
Spall Repair - Partial-Depth	SF
___-Inch Full-Depth Sawcuts	LF
Epoxy-Coated Deformed Bars	EA

**SECTION 600
STRUCTURES**

SECTION 602
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602.02 MATERIALS

602.03 CONSTRUCTION REQUIREMENTS

- A. Foundations and Substructures
 - 1. General
 - 2. Excavation and Backfill
 - 3. Placement for Dry Footing
 - 4. Underwater Placement
 - 5. Column or Wall Placement
- B. Superstructure
 - 1. General
 - 2. Deck Finishing
 - a. Metal Tine Finish
 - 3. Final Testing
 - 4. Barriers
 - a. Conventional Forming
 - b. Slip Forming
- C. Falsework
 - 1. Design and Construction
 - 2. Removal of Falsework
- D. Forms
 - 1. Design and Construction
 - 2. Removal of Forms
 - 3. Permanent Metal Concrete Forms
- E. Placing Concrete
 - 1. General
 - 2. Placement
 - 3. Vibration
 - 4. Removal of Excess Mortar
 - 5. Defective Concrete
- F. Curing Concrete
 - 1. General
 - 2. Methods
 - a. Formwork
 - b. Liquid Membrane Curing Compounds
 - c. Wet Cure
 - 3. Deck Slab Concrete
- G. Operational Limits
 - 1. General
 - 2. Mixing
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- H. Joints
 - 1. Construction Joints
 - 2. Expansion Joints
- I. Finish
 - 1. General
 - 2. Surface Finish "A"
 - 3. Surface Finish "B"
 - 4. Surface Finish "C"

- 5. Surface Finish "D"
- J. Penetrating Water Repellent Treatment of Concrete Surfaces
 - 1. Sandblasting Equipment
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- K. Anchor Bolts
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602.04 METHOD OF MEASUREMENT

602.05 BASIS OF PAYMENT

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604.02 MATERIALS

- A. Concrete for Beams
- B. Wire, Strand, and Bars
- C. Sampling and Testing
 - 1. Concrete
 - 2. Wire, Strand, and Bars
- D. Inspection
- E. Acceptance
- F. Waivers

604.03 PLANT AND EQUIPMENT

604.04 CONSTRUCTION REQUIREMENTS

- A. General
- B. Placing and Fastening Steel
- C. Placing Concrete
- D. Curing Concrete
- E. Pretensioning Method
- F. Posttensioning Method
- G. Transportation and Storage
- H. Adjacent Beams

604.05 METHOD OF MEASUREMENT

604.06 BASIS OF PAYMENT

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606.03 DESIGN AND MANUFACTURE

- A. Live Load

- B. Load Factor Design
- C. Dead Loads
- D. Applications of Loads
- 606.04 CONSTRUCTION REQUIREMENTS
- 606.05 METHOD OF MEASUREMENT
- 606.06 BASIS OF PAYMENT

SECTION 612 REINFORCING STEEL

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- 612.02 MATERIALS
- 612.03 CONSTRUCTION REQUIREMENTS
 - A. Bar List
 - B. Protection of Materials
 - C. Bending
 - D. Placing and Fastening
 - E. Epoxy Coated Reinforcing Steel
- 612.04 METHOD OF MEASUREMENT
- 612.05 BASIS OF PAYMENT

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- 616.03 CONSTRUCTION REQUIREMENTS
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 - B. Shop Inspection
 - C. Fabrication
 - 1. General
 - 2. Bolts
 - 3. Connections
 - 4. Structural Steel
 - 5. Marking and Shipping
 - 6. Shop Painting
 - 7. Blast Cleaning of Unpainted Steel
 - D. Shop Welding
 - 1. Qualification of Welders, Welding Operators, and Tackers
 - 2. Built-Up Plate Girders
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 - E. Erection
 - 1. Handling and Storing Materials

- 2. Falsework, Methods, and Equipment
 - 3. Assembling Steel
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- 618.02 MATERIALS
- 618.03 CONSTRUCTION REQUIREMENTS
- A. General
 - B. Fabrication
 - C. Excavation
 - D. Erection
 - E. Salvaging Timber for Reuse
 - F. Painting
 - G. Backfilling
- 618.04 METHOD OF MEASUREMENT
- 618.05 BASIS OF PAYMENT

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- 622.02 MATERIALS
- 622.03 CONSTRUCTION REQUIREMENTS
- A. Test Piles
 - 1. General
 - 2. Pile Formulas
 - B. Pile Driving
 - C. Pile Hammers
 - 1. General
 - 2. Gravity Hammer
 - 3. Diesel Hammer
 - 4. Air Hammer
 - D. Bearing Value
 - E. Cutoff and Treatment of Pile Heads
 - 1. Timber Pile
 - 2. Steel Piling and Steel-Encased Concrete Piling
 - F. Extensions
 - 1. Timber Pile

- 2. Steel Piling and Steel-Encased Concrete Piling
 - G. Steel-Encased Concrete Piling
 - 1. Filling With Concrete
 - 2. Reinforcement
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 - 1. Composition
 - 2. Corrosion Resistance
 - a. Fresh Water Resistance
 - b. Salt Water Resistance
 - c. Salt Fog Resistance

- B. High-Build Aliphatic Polyurethane Finish Coat
 - C. Aluminum Filled Epoxy Mastic Primer
 - 1. Composition
 - 2. Flexibility
 - 3. Resistance
 - a. Fresh Water Resistance
 - b. Salt Water Resistance
 - c. Salt Fog Resistance
 - d. Weathering Resistance
 - D. Certification and Final Acceptance
 - E. Packaging and Labeling
- 630.03 CONSTRUCTION REQUIREMENTS
- A. General
 - B. Shop Painting Structural Steel
 - 1. Surface Preparation
 - 2. Mixing and Thinning Paint
 - 3. Coating Application
 - a. Prime Coat
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 - C. Handling, Shipping, and Erecting
 - D. Field Painting
 - 1. General
 - a. Weather Conditions
 - b. Application
 - c. Protection
 - d. Responsibility for Paint Damage Claims
 - 2. Field Painting New Structural Steel
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- 630.04 METHOD OF MEASUREMENT
- 630.05 BASIS OF PAYMENT

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- 638.02 MATERIALS
- 638.03 CONSTRUCTION REQUIREMENTS
- A. Excavation
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 - C. Assembly and Installation
 - D. Backfill
- 638.04 METHOD OF MEASUREMENT
- 638.05 BASIS OF PAYMENT

SECTION 650
REPAIR AND OVERLAY OF PORTLAND
CEMENT CONCRETE BRIDGE DECK WITH LOW-SLUMP
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- 650.02 MATERIALS
 - A. General
 - B. Special Requirements for Low-Slump Concrete
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 - B. Proportioning and Mixing Equipment
 - C. Placing and Finishing Equipment
- 650.04 REMOVAL AND OVERLAY WITH THE USE OF MECHANICAL EQUIPMENT
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 - 1. Class 1 Overlay
 - 2. Class 2 Overlay
 - 3. Class 2-A Overlay
 - 4. Class 3 Overlay
 - 5. Class 4 Overlay
 - B. Construction Requirements
 - 1. General
 - 2. Removal Requirements
 - a. Class 1 Overlay
 - b. Class 2 Overlay
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 - d. Class 3 Overlay
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 - 3. Mixing of Materials
 - a. Class AAE-3 Concrete
 - b. Low-Slump Concrete
 - 4. Placing, Finishing, and Curing Overlay
 - a. General
 - b. Special Requirements for Low-Slump Concrete
 - 5. Limitations of Operations
 - C. Method of Measurement
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 - A. Classification of Removal
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 - 2. Class 2-H Removal
 - 3. Class 3-H Removal
 - B. Construction Requirements
 - 1. General
 - 2. Removal Requirements
 - a. Class 1-H Removal
 - b. Class 2-H Removal
 - c. Class 3-H Removal

- 3. Mixing of Materials
 - a. Class AAE-3 Concrete
 - b. Low-Slump Concrete
- 4. Placing, Finishing, and Curing Overlay
 - a. General
 - b. Special Requirements for Low-Slump Concrete
- 5. Limitations of Operations
- C. Method of Measurement
- D. Basis of Payment

SECTION 602 CONCRETE STRUCTURES

602.01 DESCRIPTION.

This work consists of the construction of bridges, cast-in-place box culverts, retaining walls, or portions thereof as shown on the Plans.

602.02 MATERIALS.

The materials shall meet Section 800.

602.03 CONSTRUCTION REQUIREMENTS.

Construction methods used shall be those specified for the items which constitute the completed structure together with the following requirements:

A. Foundations and Substructures.

1. **General.** Elevations and dimensions of all footings shall be as specified, unless changes are ordered in writing by the Engineer.
2. **Excavation and Backfill.** Excavation and backfill shall meet Section 210.
3. **Placement for Dry Footing.** In stable soils that stand vertically without slough or cave in on the excavation, the footing may be constructed without forms to neat lines not more than 6 inches outside the established footing limits. Payment will not be made for any increase in concrete quantities. Excavation will be computed according to Section 210.

Concrete shall not be placed in any footing until the underlying materials or bearing capability of the piles has been inspected and approved.

4. **Underwater Placement.** Foundation seal concrete shall be placed in such a manner so the water remains still during placement and curing. The cement content shall be 10 percent greater than normally required for the class of concrete specified.

Foundation seal concrete deposited under water shall be placed in its final position by a tremie or other method that prevents segregation. The tremie shall have a tube diameter of at least 10 inches and be constructed in sections having flanged couplings fitted with gaskets. The tremie shall be supported to permit free movement of the discharge end over the entire top surface of the work and to permit rapid lowering to retard or stop the flow of concrete. The discharge end shall be closed and sealed at the start of work to prevent water

entering the tube. The tremie tube shall be kept full and the concrete flow shall be placed in a manner that allows the concrete to flow while preventing water from entering the tube at the discharge end. The flow shall be continuous until work is completed. The discharge end shall remain in the deposited concrete throughout the pour.

Aluminum tremies shall not be used.

Seal concrete shall be placed continuously from start to finish. The surface of the concrete shall be kept horizontal, and each lift of concrete shall be placed before the preceding layer has taken initial set. The seal concrete shall not be disturbed after placement.

All extraneous material and seal concrete that interferes with reinforcing steel placement shall be removed.

Foundation seal concrete, which is not part of the regular substructure footing and is not a bid item, will be paid for at the same Contract Unit Price per Cubic Yard as the class of concrete specified for the footings. This price will include the 10 percent additional cement required in the foundation seal. Foundation seals will be paid for only when specified or authorized by the Engineer.

5. **Column or Wall Placement.** Concrete in columns or walls shall be placed in one continuous operation.

Concrete in the columns shall be allowed to set at least 24 hours or has reached 70 percent of design strength before placing pier cap reinforcing and concrete.

B. Superstructure.

1. **General.** In addition to Section 602.03 E, deck concrete shall not be placed until the substructure concrete is at least 14 days old or has reached 70 percent of design strength.

Beams and girders have slight variations in the anticipated camber. To build the deck to the designated thickness will required slight adjustments in deck elevation and/or riser dimensions.

Concrete placement shall not start if inclement weather is imminent.

Concrete deck slabs shall be placed in one continuous operation at a minimum rate of 25 cubic yards per hour. Concrete curbs and rails are exempt from this minimum rate but shall be placed in one continuous operation.

If concrete pouring operations is stopped, a keyed transverse construction joint shall be installed at a location determined by the Engineer. All concrete beyond the joint shall be removed. If corrective measures are not feasible and the deck is not within the specified tolerances, the unacceptable work shall be removed. Removal, reforming, cleaning or replacement of reinforcing steel, and replacement of concrete shall be at the Contractor's expense.

2. **Deck Finishing.** The deck finishing machine shall meet Section 153.09 B.

Before concrete placement, the finishing machine shall be moved across the rails to check and adjust the screed to assure that proper concrete deck thickness and cover over the reinforcing steel is obtained.

A uniform quantity of concrete shall be carried in front of the strike-off for its entire length to fill all voids and keep the finished surface at the required crown and cross section.

Following the screeding operations, final surfacing shall be obtained by using a scraping straightedge, 10 feet long with a suitable handle. The final surface shall have the required crown and shall not vary more than 1/8 inch from a 10-foot straightedge laid longitudinally thereon.

A burlap or artificial grass drag shall be pulled over the surface in a longitudinal direction while the concrete is plastic, followed immediately with the following finish:

- a. **Metal Tine Finish.** The tining device shall consist of a single row of tines capable to producing grooves at groove widths with the following spacing (in inches): 2-1/4, 2-13/16, 1-1/8, 2-5/16, 2, 1-1/8, 1-1/16, 15/16, 1-3/16, 1, 2-3/16, 2-3/8, 2-3/4, 2-5/8, 1, 2-5/8, 2, 1-13/16, 11/16, 3/4 2-1/2, 2-15/16, 2-15/16, 13/16, 1/2, 1/2, 1-1/2, 2-3/16, 7/8, 1-1/8, 1-7/16, 2-13/16, 1, 1-7/8, 2-1/16, 1-7/8, 2-3/4 7/8, 2-5/8, 3/4, 1-3/4, 1/2, 2-3/16, 1-3/4 2-3/8, 1-1/4, 2-1/16, 1-1/4, 13/16, 3/4, 1-9/16, 7/16, 1-5/8, 2-3/4, 2-7/8, 1-1/2, 1-1/2, 3/4, 1/2, 1/2, 2-11/16, 1-1/2, 2-5/16, 3/4, 1-1/8, 9/16, 2-5/8, 2-3/16, 1. The gooves shall be from 1/16 inch to 1/8 inch in depth. The tining shall be stopped 18 inches from the face of the curb and 6 inches from the beginning and end of the deck. The tining device may be hand-operated on bridge decks.
3. **Final Testing.** The entire bridge deck shall be tested for surface irregularities with a 10-foot straightedge after the concrete has hardened. Areas with a deviation greater than 1/8 inch, but less than 1/2 inch, shall be ground down until the deviation is 1/8 inch or less. The tined surface texture removed by grinding shall be restored by cutting transverse grooves with diamond-bladed equipment. All grinding and grooving shall be at the Contractor's expense. In addition to the grinding and grooving, the following penalties will be placed on each square yard or fraction thereof, of any deck surface out of tolerance after initial testing for irregularities:

Out of Tolerance

Penalty Per S.Y.

Greater than 1/8 inch and less than or equal to 1/4 inch

2-1/2 percent of Price Bid per C.Y. of Deck Concrete

Greater than 1/4 inch and less than or equal to 1/2 inch

7-1/2 percent of Price Bid per C.Y. of Deck Concrete

Greater than 1/2 inch

A determination of serviceability will be made according to Section 105.07.

4. **Barriers.** The Portland Cement Concrete for barriers shall meet Class AAE-3 of Section 802.

Lines of the barrier shall be parallel to the roadway surface and roadway centerlines. Surface tolerance shall be within 3/8 inch in a 10-foot straightedge. Corrections for surfaces out of tolerance shall be made by grinding, filling with an approved epoxy mortar, or replacing.

Barriers shall be constructed using one of the following methods:

- a. **Conventional Forming.** Expansion joint locations shall be as specified. Forms shall be adequately tied to avoid any shifting during concrete placement.

If barrier forms are held in place by concrete inserts in the deck slab, the inserts shall be removed after the forms are removed and the cavities in the deck slab shall be cleaned and filled flush with an epoxy resin adhesive meeting Section 806.

- b. **Slipforming.** The slipforming equipment shall be set to the required grade and alignment. After the reinforcement is installed, the clear distance between the reinforcement and the slipform shall be checked for the entire length of pour to assure the required depth of concrete cover is obtained.

Slab overhangs may be increased up to 1 inch in distance, and the outside of the barrier may be battered up to 1 inch, except that the Plan gutterline shall be maintained as shown.

The barrier ends shall be formed and the forms braced.

Expansion joint locations shall be as specified, and barriers shall be formed for a minimum distance of 4 feet on each side of the expansion joints.

A radius may be used in lieu of a bevel on horizontal and vertical edges of the barrier.

Except at expansion joints, 3/4-inch V-grooves shall be made in all faces of the barriers at each pier and at equal spaces between substructures at approximately 10-foot spacing.

C. Falsework.

1. **Design and Construction.** The Contractor is responsible for the design, construction, structural adequacy, and maintenance of the falsework. Provisions shall be made for adjusting the falsework while the concrete is plastic. Any falsework adjustment after the initial set will be cause for rejection. The cost to repair damage resulting from failing falsework shall be the Contractor's responsibility.

Forms shall be designed to withstand the pressures due to concrete, vibration, finishing machine, and other impacts without distortion. The forming shall be adjusted properly to accommodate the deflection and thereby maintain the total slab thickness specified in the Plans.

2. **Removal of Falsework.** The supporting wedges and falsework for concrete structures shall not be loosened or removed for 14 days after concrete placement or until the concrete has reached 70 percent of design strength.

Falsework shall be gradually and uniformly lowered to avoid excessive stresses in any part of the structure.

Falsework piles and temporary concrete footings shall be removed.

All open excavations resulting from the construction and removal of falsework shall be backfilled and compacted under Section 210 with suitable material at the Contractor's expense.

D. Forms.

1. **Design and Construction.** The Contractor shall design, construct, and maintain forms to sustain the pressure and weight of all loads and the effect of vibration as concrete is placed. Forms may be constructed of plywood, steel, or fiberglass; and all bolt and rivet heads shall be countersunk so a smooth surface is obtained. Aluminum forms shall not be used.

Forms shall be clean and in good condition.

All forms shall be built true to line and grade, mortar tight, and able to hold vibrated concrete.

For continuous steel structures, final adjustment of the deck form risers shall not be made until the all structural steel is in place. If further adjustments are required, this shall be done at the Contractor's expense.

For prestressed concrete structures, final adjustment of the deck form risers shall not be made until all prestressed members are in place. If further adjustments are required, this shall be done at the Contractor's expense.

Forms shall be beveled at all exposed corners with 3/4-inch triangular moldings.

Forms shall be treated with a form release agent before placing concrete. The release agent shall not come in contact with the reinforcing steel. Material which adheres to or discolors the concrete shall not be used.

All form ties shall be steel or fiberglass. Steel ties shall be entirely removable, or removable to a depth of at least one inch below the finished concrete surface. All fiberglass breakoffs shall be ground flush with the concrete surface. Wire ties shall not be used.

Where the bottom of the forms are inaccessible, temporary openings shall be provided for cleaning out all extraneous material before placing concrete.

Wood used for exposed surfaces shall be dressed lumber of uniform thickness and shall be lined with plywood, pressed wood, sheet metal, or other smooth sheathing materials. Plywood shall be of maximum sizes that can be cut from standard size sheets. Shiplap lumber and plain edge lumber forms may be used for surfaces to be covered with earth.

Steel forms, clamps, pins, or other connecting devices shall be designed to hold the forms rigidly together, true to shape, and to allow removal without damage to the concrete. Steel forms which do not present a smooth surface or line up properly shall not be used. Steel forms shall be free from rust, grease, or other foreign matter that discolors the concrete.

Tubes used for column forms and producing voids shall be impervious to water, and be the proper thickness and strength to remain true to shape under concrete load. Tubes which do not present a smooth surface or line up properly shall not be used.

Deck forms shall be positive riser adjustable and set to the required elevations.

2. **Removal of Forms.** All forms shall be removed, without damaging the concrete. Pry bars against the concrete shall not be used.

Forms shall be removed using the following table. If the concrete has reached 70 percent of design strength, the forms may be removed earlier than the time specified. (Days listed are exclusive of days when the temperature is below 40°F.).

Structure Element	Time
Footings	1 day
Columns and Wall Piers	3 days
Pier and Bent Caps	7 days
Abutment and Sills	1 day
Deck Slab	14 days
RCB Roof	5 days
RCB Walls	1 day

3. **Permanent Metal Concrete Forms.** Permanent metal forms for decks shall not be used unless specified. Material for permanent metal forms shall meet Section 834.04. Design and construction shall meet Section 602.03 D.1 plus the following criteria:
- The maximum deflection under the weight of the forms, plastic concrete, and reinforcement, or a load of 120 pounds per square foot, whichever is greater, shall not exceed 1/180 of the form span or 1/2 inch, whichever is less. If the computed deflection exceeds 1/8 inch, forms shall be cambered an amount equal in value and opposite in direction to the calculated deflection.
 - The form span for computation of stress and deflection shall be not less than the clear span of the form plus 2 inches.
 - Physical design properties shall be computed using the requirements of AISI Specifications for the Design of Cold-Form Steel Structural Members, latest published edition.
 - All reinforcing steel shall have a minimum clearance of 1 inch from the forms. Plan dimensions for all steel shall be maintained.

The Contractor shall submit detailed drawings showing the grade of steel, the physical and section properties for all permanent metal bridge deck form sheets, and the method of installation. The drawings shall be certified by a Registered Professional Engineer before submittal.

Form sheets shall not be placed directly on the top of the beam flanges. Sheets shall be securely fastened to form supports and shall have a minimum bearing length of 1 inch at each end. Form supports shall be placed in direct contact with the beam flanges. All attachments shall be made by hangers, clips, or other means. Welding to flanges will not be permitted.

Damaged galvanized coating on exposed form metal shall be repaired according to Section 854.02.

E. **Placing Concrete.**

1. **General.** Before placing concrete, the Engineer shall be provided a 24-hour minimum advance notice to permit final and complete inspection of forms, reinforcing steel, and other preparations. All form work shall be in place, reinforcing steel tied and other preparations complete prior to giving the 24-hour notice.

All extraneous matter shall be removed from the interior of the forms. Struts, stays, and braces used to temporarily hold forms in correct shape and alignment shall be removed when fresh concrete has reached an elevation rendering their service unnecessary. These temporary members shall not be left in the concrete.

2. **Placement.** Concrete shall be placed and consolidated without causing segregation of the aggregates. Concrete shall be placed in continuous horizontal layers. Each layer shall be placed before the preceding layer attains its initial set. Concrete shall be placed as nearly as possible in its final position.

Free fall of concrete shall not exceed 5 feet, except in thin wall construction where the reinforcement prohibits the use of tremies or chutes. In these cases, placement methods shall prevent segregation.

Open chutes shall extend, if necessary, down inside the forms or through holes left in the forms. Chutes shall be arranged to avoid steep slopes. When steep slopes are necessary, the chutes shall be equipped with baffle boards, made in short lengths that reverse the direction of movement, or terminate into a hopper with a vertical down-spout.

Tremies shall be kept full of concrete during placement. The lower end of the tremie shall be kept buried in the newly-placed concrete throughout the pour. An exception may be made by the Engineer if the rate of discharge prevents segregation.

When placing concrete in caisson foundations, the lower end of the tremie shall be buried at least 5 feet in the newly-placed concrete throughout the pour.

Concrete may be pumped from the mixer or the truck to the point of deposit in the forms. To prevent air entrainment loss, segregation of the concrete, and

damage to the epoxy-coated reinforcing steel, one of the following will be required:

- a. An s-shaped configuration at the discharge end of the conduit, or
- b. A 90 degree elbow with a minimum of 10 feet of flexible conduit placed parallel to the deck at the discharge end.

Aluminum hoppers, downspouts, chutes or tremies shall not be used.

3. **Vibration.** The concrete shall be consolidated by internal or external vibration. The vibration shall be done without displacement of reinforcing or forms. The vibration shall be of sufficient duration and intensity to thoroughly consolidate the concrete without causing segregation or localized areas of grout.

Vibrators shall be capable of visibly affecting the concrete mixture a distance of at least 18 inches from the vibrator.

Vibration shall not be applied directly to reinforcement which extends into non-plastic sections or layers of concrete. Vibrators shall not be used for moving concrete in the forms.

4. **Removal of Excess Mortar.** All accumulations of mortar from previously placed concrete on reinforcing steel and surfaces of forms shall be removed. Reinforcing steel shall be cleaned without damaging or breaking the concrete-steel bond at and near the surface of the previously placed concrete. Surfaces of unset concrete shall be kept clean.
5. **Defective Concrete.** Any section of defective concrete (spalled, honey-combed, etc.) shall be corrected to the satisfaction of the Engineer.

F. Curing Concrete.

1. **General.** All concrete surfaces not covered by forms shall be protected against evaporation of moisture for at least seven days. The curing period shall be 10 days. If the concrete is exposed to air temperatures as low as 35°F. or the mean temperature is lower than 40°F. on any day, the curing period shall be extended the number of days the concrete is exposed to these low temperatures.
2. **Methods.** All concrete surfaces except for deck slab concrete shall be protected from evaporation by one of the following:
 - a. **Formwork.** Forms shall remain in place or be replaced immediately after the concrete is finished.
 - b. **Liquid Membrane Curing Compounds.** Concrete shall be sealed by spraying a uniform film of curing compound over exposed surfaces immediately after the free water has disappeared or if forms are removed before the end of the ten-day curing period.

Liquid membrane curing compound shall meet Section 810.

Liquid membrane curing compound shall be continuously agitated and applied at a minimum rate of one gallon per 150 square feet of surface in one or more sprayings. The curing membrane shall be reapplied at the above-specified rate over any area where the membrane has been disturbed or damaged.

Liquid membrane curing compound shall not be applied to any surface which is to receive Surface Finish "C" or "D," any surface which is to receive a penetrating water repellent treatment, or any surface which forms a cold joint where fresh concrete will be placed against hardened concrete.

- c. **Wet Cure.** The concrete shall be covered with a geotextile fabric or double thickness of burlap if forms are removed before the end of the seven-day curing period, ten days when pozzolans in excess of 10 percent are used. The geotextile fabric or burlap shall be kept continuously moist for seven days or covered with a waterproof material such as polyethylene until the end of the seven-day curing period, ten days when pozzolans in excess of 10 percent are used.

Surface moisture shall be maintained between the final finish and placement of the covering by periodic applications of a light fog spray.

- 3. **Deck Slab Concrete.** The deck concrete shall be cured according to Section 602.03 F.2.c, except:
 - a. That waterproof material shall not be used to cover the fabric or burlap. If the concrete surface begins to dry between the final finish and the beginning of the wet cure, it shall be kept moist by means of a light fog spray applied so as not to damage the surface of the concrete. The wet cure material shall be placed and the wet cure started no later than 30 minutes after the finish of the completed area. The burlap or fabric shall be moistened at a minimum of every four hours. If conditions exist such as strong winds or high temperatures, causing the burlap or fabric to become dry, the watering rate shall be increased. The use of curing compounds on the deck will not be allowed. No work shall be done on the deck while the wet cure is in progress. No vehicles or equipment not required in the curing process shall be on the deck.
 - b. The curing period shall be ten days, regardless the amount of pozzolans.

G. Operational Limits.

- 1. **General.** No concrete shall be mixed, placed, or finished without adequate natural or artificial lighting.
- 2. **Mixing.** Concrete mixing operations shall be suspended whenever rain, wind, blowing dirt, extreme temperatures, or other adverse conditions occur which damage the work. The previously placed plastic concrete shall be immediately protected from damage.

After mixing, the concrete temperature shall be maintained at not less than 50°F. nor more than 90°F. until placed in the work.

If the specified temperature range cannot be maintained, the aggregates, mixing water, or both shall be heated or cooled as required. Aggregates shall not be heated by a direct flame or to a temperature exceeding 150°F. If the aggregate or the water is heated to a temperature exceeding 100°F., the aggregate and water shall be combined before being placed in contact with the cement. When heated by live steam, aggregates shall be drained as provided in Section 802.04 A.2 before being measured into the batches. Heating equipment or methods which do not heat the materials uniformly, or alter or prevent the entrainment of the specified concrete air content shall not be used. Materials containing frost or lumps of frozen material shall not be used.

3. **Placing.** Concrete shall not be placed when the air temperature is below 35°F. or is expected to fall below 35°F. within the following 24-hour period. Concrete placement shall be discontinued when a descending air temperature falls below 40°F. Concrete shall not be placed on or against frozen ground.

If the Contractor wishes to place concrete when the air temperature is below 35°F, a written request must be submitted that provides provisions for adequately enclosing the concrete and maintaining the specified temperatures. Enclosures shall be heated with electric heaters or if combustible heaters are used, be properly vented to prevent the buildup of carbon monoxide. If the request is approved, the removal and replacement of concrete that is damaged or not cured within the specified temperature control shall be at the Contractor's expense.

4. **Curing.** When the temperature falls below 35°F., the concrete surface temperature shall be maintained between 40°F. and 90°F. for the duration of the curing period.

If high early strength Portland Cement is used, the temperature shall be maintained at between 50°F. and 90°F. during the first 72-hour curing period.

Heating operations shall be discontinued so that sudden temperature changes in the concrete are avoided. Before removing the housing, the concrete's surface temperature shall be decreased to the air temperature at a rate not to exceed 15°F. per hour.

The concrete shall be protected against damage from construction operations or traffic. No work shall be conducted on the deck while the wet cure is in progress. Vehicles or equipment not required in the curing process shall not be placed on the deck until the wet curing period is completed.

Damaged concrete shall be repaired or removed and replaced at the Contractor's expense.

H. Joints.

1. **Construction Joints.** Construction joints shall be of the type, size, and spacing specified.

Before placing new concrete, the existing concrete surface and any extending steel shall be cleaned of all loose material, laitance, dirt, and other foreign matter. The existing concrete surface shall be painted with a bonding grout. The grout shall be one part cement to one part sand.

The surface shall be dry to permit some absorption of the bonding grout. Placement of the grout shall be controlled so it does not dry before concrete placement.

2. **Expansion Joints.** Preformed joint filler meeting Section 826.02 C or D, used in expansion joints, shall be placed and accurately fitted to adjacent concrete. Preformed joint filler shall not be spliced.

Concrete shall be trimmed neatly and tooled along all exposed edges of preformed fillers after removal of forms, and where necessary after rubbing. Joint filler shall not extend beyond the inner level edge on all finished surfaces.

I. Finish.

1. **General.** All formed surfaces of concrete shall receive surface finish "A." All unformed upper surfaces shall receive surface finish "B." All surfaces of concrete visible to the public shall receive surface finish "C," unless surface finish "D" is specified.
2. **Surface Finish "A."** Within 24 hours after form removal, all fins and irregular projections shall be removed from all surfaces to be exposed or water-proofed.

All form ties shall be removed to a minimum depth of 1 inch without causing spalling or damage to the concrete surface.

Cavities resulting from removing form ties, sand pockets, honeycombed areas and other holes shall be cleaned, saturated with water, and completely filled with mortar consisting of one part cement and two parts fine sand. The mortar shall not be more than 1 hour old. The mortar shall be compacted with sufficient pressure applied in pointing to fill all voids.

3. **Surface Finish "B."** All unformed upper surfaces such as tops of rails, barrier wall, posts, caps, parapets, copings, and bridge seats, (not including floors, curbs, or sidewalks), shall be struck off with a wooden template. The coarse aggregate shall be forced below the mortar surface and the surface worked with a wooden or cork float to obtain a fine-grained, smooth, but sanded texture. Mortar topping shall not be used and a steel trowel finish shall not be used on these surfaces.
4. **Surface Finish "C."** Surface finish "C" shall leave a surface that is uniform in texture and appearance, free of imperfections, depressions, or extrusions due to form marks or other reasons. Surface finish "C" shall be performed in two rubbings; the first immediately after surface finish "A" or "B" is completed and the second after the curing period is over.

All filled holes, patches, or blemishes shall be neatly rubbed to blend with adjacent surfaces.

After completion of surface finish "A" or "B," the entire surface receiving surface finish "C" shall be thoroughly saturated with water. Surfaces to be finished shall be rubbed with a medium coarse carborundum stone or me-

chanical finisher, using a small amount of mortar. The mortar shall be composed of cement and fine sand mixed in the proportions used in the concrete being finished. Rubbing shall be continued until objectionable form marks and imperfections are removed and a smooth, dense surface without pits or irregularities is produced. Rubbing shall not expose the coarse aggregate. Patches shall not be rubbed until they set, but the rubbing of the remainder of the surface shall not be delayed. The paste produced by rubbing shall be spread or brushed uniformly over the surface and allowed to reset.

The final surface finish shall be obtained by rubbing the concrete with a fine carborundum stone or an abrasive of equal quality, and water.

The final rubbing shall be done after the curing period has expired and after all concrete above the surface being finished has been cast. Rubbing shall continue until the entire surface has a smooth texture and is uniform in color and appearance. Dust, mud, or other foreign matter shall not be rubbed into the finish.

Painting or plastering concrete surfaces with neat cement or mortar shall not be used as a substitute for the specified surface finish or used with the rubbing operation.

5. **Surface Finish “D.”** Surface finish “D” is required on all surfaces as designated.

After receiving surface finish “A” or “B,” the surface shall be roughened by sandblasting to increase the bond between the surface and surface finish material. Surface finish “D” shall not be applied until the curing period is completed.

The surface finish “D” consists of an application, or applications, of a cement-based, commercially-packaged masonry coating material at the rate and application method recommended by the manufacturer. The color of the finished surface shall be that specified on the Plans or designated by the Engineer. The finish shall have a uniform texture, color, and appearance free from fins, projections, cavities, and porous spots.

- J. **Penetrating Water Repellent Treatment of Concrete Surfaces.** Penetrating water repellent treatment solution shall meet Section 822.

Surfaces to be treated with a penetrating water repellent treatment solution shall be free of dirt, dust, oil, curing compound, asphalt, salt, or other foreign material which inhibits the coverage and penetration of the water-repellent solution. Cleaning shall be performed with sandblasting or water washing equipment meeting the following requirements:

1. **Sandblasting Equipment.** Sandblasting equipment shall be the compressed air type of proper size and capacity to clean concrete surfaces.
2. **Water-Washing Equipment.** Water-washing equipment shall meet the requirements of one of the following:
 - a. Hot water pressure washer shall utilize 160°F. water temperature at 1,800 psi minimum nozzle pressure.

- b. Hydroblast washer shall utilize cold water at 7,000 psi minimum nozzle pressure.
- c. Steam Cleaning Unit shall utilize 320°F. water temperature at 305 psi operating pressure.

Surface preparation includes the application of pre-treatment cleaning agents before the use of water-washing cleansing methods.

Solvents and hand tools shall be used to remove bonded foreign materials.

To facilitate water-washing methods, detergent may be added to the cleansing water. Final rinsing with clear water shall follow the washing procedure.

The cleaning process shall not damage the concrete surface, remove or alter the existing surface finish, or expose the coarse aggregate.

Before treatment, the concrete surface shall be free of surface moisture which inhibits the penetration of the water repellent solution. If necessary, the surface shall be allowed to dry until it meets the specific requirements of the repellent manufacturer.

Penetrating water repellent treatment solution shall be applied after the barrier forms have been removed and the air or concrete surface temperature is 40°F. and rising. Airless application equipment shall be used with 15 to 40 psi application pressure. Treatment solution shall be uniformly applied at the rate recommended by the solution manufacturer.

- K. **Anchor Bolts.** Anchor bolts for bearing may be set directly in the plastic concrete, grouted in preformed holes, or grouted in drilled holes.
- L. **Bearings.** Masonry bearing plates, pedestals, etc., shall be accurately set in position to within .01 feet of the specified elevation. Bearing areas shall be finished to a true plane and elevation by grinding, if necessary, before bearing plates or pads are set. The sliding surfaces of expansion bearings shall be cleaned and lubricated.
- M. **Live Load.** Vehicles shall not be permitted on any span until the concrete has attained at least 70 percent of its design strength.

602.04 METHOD OF MEASUREMENT.

- A. **General.** Quantities which constitute the completed and accepted structures will be measured for payment. Only work accepted by the Engineer will be included, and the dimensions used will be those shown on the Plans or ordered in writing.
- B. **Concrete.** The pay quantity of concrete will be computed by the cubic yard based on the dimensions shown on the Plans or authorized by Change Orders. Each Class of Concrete or High Early Strength Concrete designated as a pay item will be measured separately.
- C. **Cement.** When separate payment is provided, the Portland Cement will be measured by the Ton. The pay quantity will be the number of Tons used as authorized. Cement used according to Section 802.01 C.2.a and cement which is lost, wasted,

or used in concrete poured outside the authorized dimensions will not be included in the quantity measured for payment.

602.05 BASIS OF PAYMENT.

- A. **General.** Payment will be made at the Contract Unit Price for the items listed in the Contract.

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

- B. **Concrete.** When designated in the Contract, Concrete or High Early Strength Concrete will be paid for at the Contract Unit Price bid per Cubic Yard for the class of Concrete specified and furnished.

- C. **Cement.** When designated in the Contract, Cement will be paid for at the Contract Unit Price bid per Ton of Cement used as authorized.

Cement not designated as a Contract pay item will be considered as an integral part of the concrete and no separate payment will be made except for Cement used under circumstances described in Sections 802.01 C.2 and 802.01 E.2. Cement used as described in Sections 802.01 C.2 and 802.01 E.2 will be paid for at the rate of 1.25 times the delivered cost of the Cement based upon receipted invoices and freight charges. This payment will be considered full compensation for any added costs incurred by the Contractor in the work.

**SECTION 604
PRESTRESSED CONCRETE BEAMS**

604.01 DESCRIPTION.

This work consists of furnishing required materials as well as fabricating, transporting, erecting, finishing, and adjusting prestressed concrete beams.

604.02 MATERIALS.

- A. **Concrete for Beams.** All concrete shall be produced and composed of materials meeting Section 802. The concrete's compressive strength shall be based on tests of 6 × 12-inch cylinders. The prestressed beam concrete strength is considered satisfactory when test cylinders obtain a minimum compressive strength of 5,000 psi.

The Contractor shall furnish cylinder molds and cast the test specimens in the presence of the Engineer. Test specimens shall be cured for the same length of time and under identical conditions used for the beams. The Contractor shall cast, cure,

and test a minimum of ten 6 × 12-inch compression test cylinders according to Section 802.01 F.6, using concrete proportioned according to the proposed concrete mix design and using ingredients representative of those proposed for the manufacture of the beams. Four specimens shall be tested at 14 days, and the remaining six at 28 days. These test results shall accompany the proposed concrete mix design which must be submitted to the Engineer at least 14 days before casting the beams. The trial mix of the proposed concrete design shall be produced in the presence of the Engineer. Concrete test specimens shall be molded, cured, and tested under supervision of the Engineer.

After approval of the concrete mix design, no changes shall be made in the design or its ingredients without an approved revised mix design.

Portland Cement may be of any type permitted in Section 802 provided that when air-entraining or admixtures are used, the air content shall not be less than 4 percent nor more than 7 percent when tested according to Section 802.01 F.3.

Admixtures for water reduction to obtain increased compressive strength and workability may be used if provided for in the established mix design.

The same brand, grade, and kind of cement and admixture shall be used for all beams in any one bridge structure.

- B. **Wire, Strand, and Bars.** All wire, strands, and anchorage assemblies furnished shall be assigned a lot number and tagged for identification. This material shall meet Section 836.03 E.

Concrete reinforcement shall meet Section 612. Grade 60 shall be used unless otherwise specified.

C. **Sampling and Testing.**

1. **Concrete.** Test cylinders shall be cast in a sequence so all concrete utilized in the beams is represented by tests.

If a single beam is cast, a minimum of five test cylinders shall be cast and tested. Two cylinders will be tested for determining the concrete compressive strength at time of stress transfer and three for determining the compressive strength for delivery and obtaining acceptance by the Department on or before the standard 28-day test period.

If two or more beams are cast during one continuous operation, a minimum of six test cylinders shall be cast and tested. A minimum of three test cylinders will be tested per bed with one cylinder representing the first beam cast, one cylinder representing a beam near the center of the bed, and one cylinder from the last beam cast. The three remaining cylinders are for determining compressive strength to make delivery and obtaining acceptance by the Department on or before the standard 28-day test period.

Additional test cylinders may be cast for tests desired by the Contractor and the cost of testing paid for by the Contractor.

2. **Wire, Strand, and Bars.** A certified mill test report shall be submitted to the Engineer for these items supplied for the Project. This report shall contain an

affidavit stating the material meets Specifications and show diameters, elongation at rupture, and ultimate tensile strengths.

The Engineer reserves the right to sample and test these materials, and test results shall govern acceptance or rejection of materials tested.

- D. **Inspection.** A minimum of two weeks notice shall be provided before beams are manufactured so the Department can arrange for inspection.

The Engineer shall have free entry to all parts of the work involving the manufacture of beams under the Contract.

- E. **Acceptance.** Acceptance of materials or finished work by the Engineer will not prevent subsequent rejection of defective work and materials.

Beams may be accepted and delivered to the Project when minimum strength requirements are obtained.

Beams not meeting these minimum strength requirements at 28 days will be rejected.

The Contractor shall furnish a certified statement, confirmed by the Department's representative, showing the number of girders cast in each continuous operation and the number of each girder.

- F. **Waivers.** If the beam fabricators plant meets the requirements of the Department's Quality Assurance procedures, the sampling, testing, and inspection requirements specified in Sections 604.02 A., 604.02 C., and 604.02 D. may be waived and the following substituted:

The Contractor shall furnish six copies of a certificate stating the source of materials and that the materials used in manufacturing and the construction of the beams meet the required Specifications.

The Contractor shall furnish the required certificate for the wire strand and reinforcing and a certificate analysis of the aggregates and stating that the aggregates have been tested and approved. Concrete test cylinders shall be cast, cured, and tested at the Contractor's expense. At the time of stress transfer, as specified on the shop drawings, two concrete test cylinders will be tested for a single beam pour, and three concrete test cylinders will be tested for a continuous pour representing the beams as provided for in Section 604.02 C.1.

The Department reserves the right to sample and test all materials at the point of manufacture or after delivery to the work site. The results of the tests shall govern acceptance or rejection of materials tested.

604.03 PLANT AND EQUIPMENT.

Plant and equipment used in this work shall meet Section 151.01 and 153. Written permission may be granted for using other types of concrete mixers.

Cement shall be weighed on a scale that is not used for other ingredients.

604.04 CONSTRUCTION REQUIREMENTS.

- A. **General.** The Contractor shall furnish skilled personnel to provide aid and instruction in using prestressing equipment and installing materials to obtain specified results.

The prestress force applied to the strands shall be determined by strand elongation, and checked by calibrated hydraulic jacks. The Contractor shall furnish a certified statement of curve giving the load elongation relationship at 75 percent (low relaxation strand) of ultimate stress for the prestress steel to be used. A certified calibration curve shall be furnished for each hydraulic jack.

Beams shall conform to dimensions specified or shown on the shop drawings.

Shop drawings generated by a computer automated drafting (CAD) system may be submitted on 11-inch by 17-inch detail sheets. Each sheet shall be consecutively numbered and have a title giving the project number, the bridge number, the fabricator's name, the fabricator's contract number, and a brief description of the details shown on the sheet.

Shop drawings shall show all beam dimensions; the size and location of all reinforcing and prestressing steel; the details of end anchorages if used, and any necessary revisions to bridge seats. Two copies of shop drawings shall be submitted to the Engineer for review. If shop drawings are returned for revision, revisions shall be made and resubmitted to the Engineer. The time required for the review of each submittal will not exceed 14 days after the shop drawings are received by the Engineer. Six copies of the reviewed and final drawings shall be furnished to the Engineer before fabrication.

Calculations and work drawings produced by the supplier used in the design of prestressed concrete beams shall be signed, sealed, and dated by a Professional Engineer duly registered in the State of North Dakota.

- B. Placing and Fastening Steel.** All steel units shall be accurately placed and firmly held in position during the placing and setting of concrete.

Distances between the forms and steel units shall be maintained by stays, ties, hangers, or other approved supports. Metal bar chairs and bolsters in contact with the forms shall be galvanized or noncorrosive metal. Wooden blocks shall not be left in the concrete.

To insure proper positioning, prestressing elements shall be straightened by applying low initial tension. This initial tension shall be included in the total tension applied. Suitable horizontal and vertical spacers shall be provided, if required, to hold elements in true position.

- C. Placing Concrete.** Concrete shall be measured, mixed, handled, and placed according to applicable provisions of Sections 602 and 802.

Concrete for the beams shall be vibrated internally, or externally, or both. The vibrating shall be done without displacement of reinforcing, conduits, voids, or wire. The vibration shall be of sufficient duration and intensity to thoroughly consolidate the concrete without causing segregation.

- D. Curing Concrete.** Members shall be water or steam cured until the compressive strength specified in the shop drawings for applying the prestress force is reached. Members shall be protected from rain, cold weather, and moisture loss between placement of the concrete and the beginning of the water or steam cure.

Steam cured members shall be covered with tarpaulins or other suitable covering to contain the live steam. The steam shall be uniformly distributed throughout the enclosure and shall not be jetted directly on the beam. The temperature of the enclosure shall not be raised above 90°F. until the beam has cured for a minimum of three hours. After this period the temperature within the beam enclosure may be raised to a maximum of 160°F. in increments not to exceed 40°F. per hour.

Water cure consists of covering all exposed surfaces with a fabric or double thickness of wet burlap and applying water to the covering so the concrete surface is kept continuously wet.

The exposed surfaces of each unit shall be covered when the fabric or wet burlap can be placed without damaging the concrete.

A uniform curing temperature shall be maintained.

- E. **Pretensioning Method.** The prestressing tendons shall be accurately held in position and stressed by jacks. A record shall be kept of the jacking force and the elongation produced. Several units may be cast in one continuous line and stressed at one time. No bond stress shall be transferred to the concrete or end anchorages released until test cylinders have reached the detensioning strength specified on the shop drawings.

Tendons shall not be cut without first being heated to relieve the stress. Cutting shall be done so the lateral eccentricity of prestress force is minimized.

- F. **Posttensioning Method.** The type of prestressing system and the method of computing the prestress losses shall be as approved. The tensioning process shall be conducted so the tension being applied and the elongation of the prestressing elements may be measured. The prestressing sequence shall keep the lateral eccentricity of the prestress to a minimum. For "draped" prestressing elements, the jacking shall be done from both ends of the beams when the angle between the horizontal and the directions of the element at its end exceeds 5 degrees. A record of the jacking force and elongation during jacking shall be kept and submitted for approval. A stress of approximately 400 psi shall be placed on the prestressing steel before elongation measurements are started. The enclosures for prestressing steel shall be an approved type and shall be accurately placed at the locations shown. The enclosures shall be watertight and securely held to avoid vertical or horizontal displacement from true alignment during concrete placement. Enclosure tubes shall be provided with pipes or suitable connections for the injection of grout.

After tensioning is completed and the prestressing steel is anchored, the enclosures shall be bonded by pressure grouting the space between the inside perimeter of the tube and the prestressing steel. The final pressure placed on the grout shall be sufficient to force the grout completely through the tube and to ensure penetration into all voids in the enclosures. The final grout pressure shall range from 50 to 100 psi.

The grout shall be mixed to the consistency of thick paint and shall be proportional by volume consisting of one part Portland Cement, 0.75 part (maximum) of sand passing a No. 30 sieve, and 0.75 part (maximum) of water.

- G. **Transportation and Storage.** Precast beams shall be transported in an upright position, and points of support and directions of the reactions with respect to the beam should be approximately the same during transportation and storage as when the beam is in its final position.

Beams damaged before final acceptance shall be replaced or repaired at the Contractor's expense.

- H. **Adjacent Beams.** A variance in the top surface of adjacent beams by 3/8 inch or more shall be corrected using one of the following methods:
1. Weighting or shimming the beams.
 2. Addition of extra grout at the keyway joint to provide a transverse slope no steeper than 24:1 between adjacent beams. Contact surfaces shall be cleaned before grouting.

604.05 METHOD OF MEASUREMENT.

Prestressed Beams will be measured by the Linear Foot complete and in place.

The costs of end anchor plates and devices, all reinforcing bars, prestressing wires, and other accessories embedded in the beam (including sole plates when required) and the required grout shall be included in the bid item "Prestressed Beams." End caps and diaphragms required to be cast in place after the beams are placed on the supports will be measured as concrete by the cubic yard.

604.06 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price as follows:

Pay Item	Pay Unit
Prestressed Beams	Linear Foot
Concrete	Cubic Yard

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

SECTION 606 PRECAST REINFORCED CONCRETE BOX CULVERTS

606.01 DESCRIPTION.

This work consists of furnishing required materials as well as fabricating, transporting, and installing precast reinforced concrete box culverts.

606.02 MATERIALS.

Prestressing strands, wire, and bars shall meet Section 836.03E.

Geotextile fabric shall meet Section 709.

606.03 DESIGN AND MANUFACTURE.

The design and manufacture of the precast RCB shall satisfy the applicable portions of *AASHTO Standard Specifications for Highway Bridges*, Division I, Section 17, and "AASHTO Materials Specification M 259." The design shall also meet or exceed the following criteria:

A. Live Load. HS25**B. Load Factor Design.**

1. Dead Load Factor = 1.30
2. Live Load Factor = 2.17
3. Strength Reduction (Phi) Factors
 - a. Shear = 0.85
 - b. Flexure = 0.9

C. Dead Loads.

1. Concrete = 150 lbs./cu. ft.
2. Earth = 120 lbs./cu. ft.
3. Lateral Earth = 40 lbs./sq. ft./ft. of depth

D. Applications of Loads. The RCB shall be designed for the greater moments and shears resulting from the following two load conditions:

1. Dead Load + Live Load + Balanced Lateral Earth Load
2. $0.8 \times (\text{Dead Load} + \text{Live Load} + \text{Unbalanced Lateral Earth Load})$. The unbalanced lateral earth load occurs when one side of the culvert has 40 lbs./sq. ft./ft. of depth while the other side has 20 lbs./sq. ft./ft. of depth.

The precast RCB shall be comprised of barrel sections and end sections. The concrete used to make the sections shall have a minimum compressive strength of 3,000 psi and shall have a minimum cement content of six sacks per cubic yard.

The barrel sections shall not be any shorter than 4 feet long. The minimum thickness of the barrel parts are 8 inches for the roof, floor and walls. Any haunch or fillet at the inside corners of the barrel shall not exceed a triangular shape with 12-inch horizontal and 12-inch vertical legs. The barrel section joints shall be tongue and groove, a minimum of 4 inches long and a width of 3-1/2 inches at the end of the tongue.

606.04 CONSTRUCTION REQUIREMENTS.

The Contractor shall submit shop drawings to the Engineer for review before the manufacture of the RCB sections. These shop drawings shall show a minimum of the following:

- A. Layout showing RCB placement and clearances.
- B. Type and strength of concrete and reinforcing steel.
- C. All concrete and reinforcing dimensions.
- D. Reinforcing steel clearances.
- E. Method of tying sections together.
- F. Method of covering the joints.
- G. Installation and handling instructions.

The Contractor must give at least ten working days notification to the district materials coordinator of the date and location of fabrication. Calculations and work drawings produced by the supplier used in the design of prestressed concrete beams shall be signed, sealed, and dated by a Professional Engineer duly registered in the State of North Dakota.

The installation of the precast RCB shall satisfy the applicable portions of *AASHTO Standard Specifications for Highway Bridges*, Division II, Section 27 and Section 210 of the Department's *Standard Specifications for Road and Bridge Construction*. The backfill shall be compacted to 85 percent standard density per AASHTO T 180. The Contractor shall provide a 2-inch minimum thickness of uncompacted (screedable) fine granular material under the RCB for a leveling course. This fine granular material shall not be paid for separately but shall be included in the bid item "Precast RCB Culvert."

The joints should fit as tightly as possible, with a maximum of 1 inch between barrel sections.

The four outside surfaces of each barrel section joint shall be wrapped with a geotextile fabric that prevents soil from leaking through the joint. The geotextile fabric shall be a minimum of 24 inches wide and shall meet the requirements of Geotextile Separation Fabric of Section 709. Geotextile fabric shall also be required at the outside face of each cutoff wall vertical joint, if more than one unit is used.

The costs of providing and installing the strands and the geotextile fabric to wrap the barrel shall be included in the bid item "Precast Reinforced Concrete Box Culvert."

606.05 METHOD OF MEASUREMENT.

Precast reinforced concrete box culverts will be measured by the linear foot complete and in place.

Precast reinforced concrete box culvert end sections will be measured by the unit complete and in place.

All hardware embedded in the reinforced concrete box culverts and end sections, all prestressing strands, hardware, bolts, and steel plates used to fasten the barrel sections and end sections together shall be included in the bid item "Precast Reinforced Concrete Box Culvert" and the item "Precast Reinforced Concrete Box Culvert End Section."

606.06 BASIS OF PAYMENT.

Payment will be made at the contract unit price as follows:

Pay Item		Pay Unit	
Single _____	× _____	Precast RCB culvert	Linear foot
Double _____	× _____	Precast RCB culvert	Linear foot
Single _____	× _____	Precast RCB culvert end section	Each
Double _____	× _____	Precast RCB culvert end section	Each

SECTION 612 REINFORCING STEEL

612.01 DESCRIPTION.

This work consists of furnishing and placing reinforcing steel.

612.02 MATERIALS.

Reinforcing steel shall meet Section 836 and furnished in the full lengths specified.

612.03 CONSTRUCTION REQUIREMENTS.

- A. **Bar List.** The bar list and bending schedule in the Plans are for estimating quantities. The Contractor shall verify the quantity, size, and shape of the bar reinforcement against the structure drawings and immediately notify the Engineer of any errors. Errors in the bar list and bending schedule shall not be cause for adjustment of the Contract Unit Price.

The bar fabricator shall add a prefix to all bar designations to differentiate between the different structures on the same project.

- B. **Protection of Materials.** Reinforcing steel shall be protected from damage and be free from dirt, detrimental scale or rust, paint, oil, and other foreign substance when incorporated into the work. The reinforcing steel shall be stored above the ground surface on platforms, skids, or other supports.
- C. **Bending.** All reinforcing bars shall be bent cold according to ACI 318. Bars partially embedded in concrete shall not be field bent unless specified.

- D. **Placing and Fastening.** All reinforcing steel shall be accurately placed and firmly held in position by supports and fasteners and will be inspected and approved before concrete placement. Bars shall be tied at all intersections except where the spacing is less than 12 inches in any direction, in which case only alternate intersections need to be tied. Welding, flame cutting, or heating of bars will not be permitted.

The top layer of transverse deck slab reinforcing steel shall be tied to the shear connectors at each girder line at a maximum longitudinal spacing of 6 feet. If shear connectors are not installed, ties shall be made to the deck forms at a maximum longitudinal and transverse spacing of 6 feet. Two wraps with 14-gauge non-corrosive ties shall be used for these ties.

Bar supports shall be made of mortar, plastic, or metal. Metal bar supports that rest on the forms shall have corrosion-proof legs. Maximum spacing of slab bolsters and bar supports for deck slabs shall be 4 feet.

Bundled bars shall be tied at intervals not to exceed 6-foot centers.

The clear distance to the top of the deck reinforcing steel shall be checked and adjusted for clearance according to Section 602.03 B.2.

Changes to the location or number of reinforcing bar splices will not be permitted.

- E. **Epoxy-Coated Reinforcing Steel.** All equipment used to handle epoxy coated reinforcing bars shall be padded wherever the equipment is in contact with the bars. Bundled bars shall be lifted with multiple supports, or a platform bridge to prevent abrasion in the bundle. Bundles shall be transported carefully and never dropped or dragged. Bundles shall be stored on padded or wooden supports. If the bars are exposed to ultraviolet rays for 60 calendar days or more after fabrication, the bars shall be covered with opaque polyethylene or other suitable protective material. This shall include the time the rebar is in place on the deck prior to concrete placement. Provisions shall be made for adequate ventilation to prevent condensation under the covering.

Damaged epoxy coating shall be repaired before concrete is placed. Repairs shall be made using material and procedures recommended by the manufacturer. All visible signs of oxidation and rust shall be removed completely before repairs are made. When the extent of damaged coating exceeds 2 percent of the surface area of the coated reinforcing bar in any 1-foot length, the bar shall be rejected. When the extent of damage does not exceed 2 percent of the surface area in any 1-foot length, the bar may be used providing all damage discernible to a person with normal or corrected vision is repaired with patching material. The area covered by patching material, excluding patched cut ends, shall not exceed 5 percent of the surface area of the coated reinforcing bar.

Plastic, plastic-coated, or epoxy-coated bar supports shall be used to support epoxy-coated reinforcing bars. The wire tying for epoxy-coated reinforcing bar shall be plastic coated.

612.04 METHOD OF MEASUREMENT.

Reinforcing Steel will be measured by the Lump Sum or by the Pound in place as specified or placed as ordered by the Engineer. Quantities of materials will be based upon

the calculated weights of the Reinforcing Steel. The weights for steel bar reinforcement calculated will be based upon the following table:

Size	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8
Wt. per Linear foot in pounds	0.376	0.668	1.043	1.502	2.044	2.670
Size	No. 9	No. 10	No. 11	No. 14	No. 18	
Wt. per Linear foot in pounds	3.400	4.303	5.313	7.65	13.60	

The costs of supports, separators, ties, and other devices used for holding the reinforcement in place shall be included in the bid item "Reinforcing Steel."

612.05 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price as follows:

Pay Item	Pay Unit
Reinforcing Steel	Pound, Lump Sum
Reinforcing Steel (Epoxy Coated)	Pound, Lump Sum

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

SECTION 616 STRUCTURAL STEEL

616.01 DESCRIPTION.

The work consists of fabricating, furnishing, delivering and erecting structural steel.

616.02 MATERIALS.

Material shall meet the following:

Item	Section
Structural Carbon Steel	834.01 A
High Strength, Low-Alloy Steel	834.01 B
High Strength, Low-Alloy Structural Steel With 50,000 psi Minimum Yield Point to 4-inch thick	834.01 C
Structural Steel for Pins and Rollers	834.01 E
Steel Forgings	834.02 A
Steel Castings	834.02 B
Gray Iron Castings	834.02 C
Malleable Castings	834.02 D
Bronze Bearing and Expansion Plates	834.02 F
Cast Aluminum	834.02 H
Lead Sheet and Plates	834.02 I
Brass Sheet	834.02 J
Copper Sheet	834.02 K
Structural Bolts, Nuts, and Washers	834.03
Direct Tension Indicators	834.03 C

Welded Stud Shear Connectors shall meet the most recent AASHTO *Standard Specifications for Highway Bridges*.

616.03 CONSTRUCTION REQUIREMENTS.

- A. **Shop Detail Drawings.** The Contractor shall prepare all work drawings (detailed shop drawings, erection diagrams, etc.) required for the fabrication and erection of steel.

Shop drawings consist of detailed plans showing dimensions and sizes of materials for fabrication, bolt lists for field erection, a match-marking diagram, and a complete field erection plan.

Shop drawings shall be 22 inches by 36 inches. Shop drawings generated by a computer-aided design (CAD) system may be submitted on 11-inch by 17-inch detail sheets. Each sheet shall be consecutively numbered and have a title giving the project number, bridge number, the fabricator's name, the fabricator's contract number, and a brief description of the details shown on the sheet.

Two sets of drawings, or more if required, shall be submitted to the Engineer for approval 14 days, or as specified in the Contract, before fabrication. The Engineer will return one set approved or with corrections and changes noted. Drawings containing corrections or changes shall be resubmitted in duplicate until approved by the Engineer. Additional time required to make adjustments to shop drawings due to the Contractor's errors or omissions is the responsibility of the Contractor. Additional work or file copies of approved drawings shall be provided as requested.

The Contractor shall be responsible for the accuracy of shop drawings and report any discrepancies to the Engineer for revision and correction before fabrication is begun. Any material ordered or work done by the Contractor before the drawings have been approved shall be at the Contractor's risk.

The Engineer's review and approval applies only to the requirements for strength and arrangements of parts and details and does not relieve the Contractor of full responsibility for the accurate assembly and fitting of all structural members.

B. Shop Inspection.

Shop inspection personnel shall meet the qualifications stated in the latest AASHTO/AWS D 1.5 Bridge Welding Code regarding inspection personnel qualifications.

Shop inspection of welded plate girders will be required. Shop inspection of other steel members will be required when ordered by the Engineer. The Contractor shall provide the Engineer at least three weeks notice before beginning fabrication.

The Contractor shall furnish facilities for the inspection, allow the Inspector access to all areas, and furnish at least two 4-inch by 18-inch samples of each grade and brand of structural steel for testing without charge.

The Inspector shall have authority to reject materials or work which do not meet the specified requirements.

Acceptance of materials or work by the Inspector shall not prevent subsequent rejection if found defective.

C. Fabrication.

1. **General.** Fabrication shall meet the latest AASHTO/AWS D 1.5 Bridge Welding Code except as changed by this Specification. For structures that carry railroad traffic, the structural steel shall be fabricated according to the AREMA Specifications.
2. **Bolts.** Permanent field connections shall be made using 7/8-inch diameter AASHTO M 164 high-strength bolts, unless otherwise noted.

The diameter of the bolt holes shall be 1/16 inch greater than the diameter of the bolts used. Bolts transmitting shear shall be threaded to such a length that not more than one thread is within the grip of the metal. The bolts shall be of a length to extend entirely through the nuts but not more than 1/4 inch beyond the face of the nut. One lock washer shall be placed under the nut of each bolt connecting handrails. A hardened washer shall be installed over slotted holes.

Galvanized nuts shall be checked to verify that a visible lubricant is on the threads.

Black bolts shall be oily to the touch when delivered and installed.

Weathered or rusted bolts and nuts that are not lubricated shall be cleaned and relubricated before installation. Recleaned or relubricated bolt, nut and washer assemblies shall be retested according to Section 616.03 C.3.a.

3. **Connections.** The assembly of structural joints using high strength steel bolts tightened to a high tension shall meet the following requirements:

- a. The rotational-capacity test described in Section 834.03 B. shall be performed on each rotational-capacity lot before starting bolt installation. Hardened steel washers are required for tests, but they may not be required in the actual installation procedures.

A Skidmore-Wilhelm Calibrator or an acceptable equivalent tension measuring device will be provided by the Department at each project site during erection. Periodic testing (at least once each working day when the calibrated wrench method is used) shall be performed by the Contractor and verified by the Engineer to assure compliance with the installation test procedures of Section 616.03 C.3.b for Turn-of-Nut Tightening, Calibrated Wrench Tightening, and Direct Tension Indicator Tightening. Bolts too short for the Skidmore-Wilhelm Calibrator may be tested using direct tension indicators. The direct tension indicators must be calibrated in the Skidmore-Wilhelm Calibrator using longer bolts.

- b. Bolted parts shall fit firmly together when assembled. Contact surfaces, including those adjacent to the washers, shall be descaled or carry the normal tight mill scale. Contact surfaces shall be free of dirt, oil, loose scale, burrs, pits and other defects that would prevent solid seating of the parts. Bolts shall be installed with nuts on the interior side of the web and on the upper side of the flange.

Bolts shall be installed with a hardened washer under the nut or bolt head, whichever is the element turned in tightening. A flat washer may be used when the abutment surface adjacent to 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. Where an outer face of the bolted parts has a slope of more than 1:20 with respect to a plane normal to the bolt axis, a smooth beveled washer shall be used to compensate for lack of parallelism. All fasteners shall be tightened to give at least the required minimum bolt tension values shown in Table 1 on completion of the joint. Tightening shall be done with properly calibrated torque wrenches, the turn-of-nut method, or direct tension indicators.

Table 1
Required Fastener Tension

Bolt Size (inches)	Minimum Bolt Tension* (pounds)
1/2	12,000
5/8	19,000
3/4	28,000
7/8	39,000
1	51,000
1-1/8	56,000
1-1/4	71,000
1-3/8	85,000
1-1/2	103,000

- * Equal to 70 percent of specified minimum tensile strength of bolts (as specified in ASTM Specifications for tests of full size A-325 bolts with UNC threads loaded in axial tension).
- c. High tensile strength bolts (AASHTO M 164) which have been tightened previously to the minimum bolt tension specified in Table 1 shall not be reused. Any high tensile strength bolt which must be loosened and retightened for any reason shall be replaced with a new bolt and nut. The Contractor shall bear the cost of bolts and nuts replaced under this requirement.
- (1) Turn-of-Nut Tightening. When the turn-of-nut method is used to provide the bolt tension specified in Table 1, all bolts in the joint shall first be brought to a "snug tight" condition to ensure the parts of the joint 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 worker using an ordinary spud wrench. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table 2 with tightening progressing systematically from the rigid part of the joint to its free edges. During this operation, there shall be no rotation of the part not turned by the wrench.

Table 2
Nut Rotation from Snug Tight Condition (a), (b)
Disposition of Outer Faces of Bolted Parts

Bolt Length (underside of head to end of bolt)	Both faces normal to bolt axis	One face normal to both axis and other sloped not more than 1:20 (beveled washer not used)	Both faces sloped not more than 1:20 from nor- mal to the bolt axis (beveled washers not used)
Up to and in- cluding 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 (c)	2/3 turn	5/6 turn	1 turn

- (a) 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 plus or minus 30 degrees; for bolts installed by 2/3 turn and more, the tolerance should be plus or minus 45 degrees.

- (b) Applicable only to connections in which all material within the grip of the bolt is steel.
 - (c) No research has been performed by the Research Council on Riveted and Bolted Structural Joints to establish the turn-of-nut procedure for bolt lengths exceeding 12 diameters. Therefore, the required rotation must be determined by actual test in a suitable tension measuring device which simulates conditions of solidly fitted steel.
- (2) **Calibrated Wrench Tightening.** Calibrated wrench tightening may be used only when installation procedures are calibrated on a daily basis and when a hardened washer is used under the element turned in tightening.

Calibrated wrenches shall be set to provide a tension not less than 5 percent in excess of the minimum tension specified in Table 1. Calibration shall be accomplished in a device capable of indicating actual bolt tension by tightening three typical bolts of each diameter, length and grade from the bolts being installed and with a hardened washer from the washers being used in the work under the element turned in tightening. Wrenches shall be recalibrated when significant difference is noted in the surface condition of the bolt threads, nuts or washers. It shall be verified during actual installation in the assembled steelwork that the wrench adjustment selected by the calibration does not produce a nut or bolt head rotation from snug tight greater than that permitted in Table 2. If manual torque wrenches are used, nuts shall be turned in the tightening direction when torque is measured.

Bolts shall be installed with hardened washers under the element turned in tightening bolts in all holes of the connection and brought to a snug tight condition. Following this initial tightening operation, the connection shall be tightened using the calibrated wrench. Tightening shall progress systematically from the most rigid part of the joint to its free edges. The wrench shall be returned to "touch up" previously tightened bolts which may have been relaxed as a result of the subsequent tightening of adjacent bolts until all bolts are tightened to the prescribed amount.

- (3) **Direct Tension Indicator Tightening.** Direct tension indicators shall be as specified in Section 834.03 C. A representative sample of not less than three direct tension indicator devices for each diameter and grade of fastener to be used in the work shall be assembled in a calibration device capable of indicating bolt tension. The test assembly shall include flat hardened washers, if required in the actual connections, arranged as those in the actual connections to be tensioned. The calibration test shall demonstrate that the device indicates a tension not less than 5 percent greater than required by Table 1.

Manufacturer's installation procedure shall be followed for installation of bolts in the calibration device and in all connections. Special attention shall be given to proper installation of flat hardened

washers when direct tension indicator devices are used with bolts installed in oversize or slotted holes and when the load indicating devices are used under the turned element.

Bolts shall be installed in all holes of the connection and brought to snug tight condition. Snug tight is indicated by partial compression of the direct tension indicator protrusions. All fasteners shall then be tightened, progressing systematically from the most rigid part of the connection to the free edges in a manner that will minimize relaxation of previously tightened fasteners. In some cases, proper tensioning of the bolts may require more than a single cycle of systematic partial tightening prior to final tightening to deform the protrusion to the specified gap.

- (4) **Alternate Design Bolt Tightening.** Fasteners which incorporate a design feature intended to indirectly indicate the bolt tension or to automatically provide the tension required by Table 1 shall meet the requirements of Section 834.03 B. Verification testing using a representative sample of not less than three bolt and nut assemblies of each diameter, length and grade to be used in the work shall be performed at the job site in a device capable of indicating bolt tension. The test assembly shall include flat-hardened washers, if required in the actual connection, arranged as in the actual connections to be tensioned. The verification test shall demonstrate that each bolt develops a tension not less than 5 percent greater than the tension required by Table 1. Manufacturer's installation procedure shall be followed for installation of bolts in the calibration device and in all connections. Periodic retesting shall be performed when ordered by the Engineer.

When alternate design fasteners which are intended to control or indicate bolt tension of the fasteners are used, bolts shall be installed in all holes of the connection and initially tightened sufficiently to bring all plies of the joint into firm contact but without yielding or fracturing the control or indicator element of the fasteners. All fasteners shall then be further tightened, progressing systematically from the most rigid part of the connection to the free edges in a manner that will minimize relaxation of previously tightened fasteners. Proper tensioning of the bolts will require more than a single cycle of systematic partial tightening prior to final twist-off of the control or indicator element of individual fasteners. If twist-off occurs prior to the final tightening cycle, the individual fastener shall be replaced with a new one.

4. **Structural Steel.** Structural steel shall be AASHTO M 270, Grade 36T2, Grade 50T2, or Grade 50WT2, except the requirement for Charpy V-Notch test is waived for the bearings, ice nose, diaphragms, and diaphragm connection material.

Shear connectors on splice plates shall be moved to clear bolt holes.

Shop-welded connections of diaphragm angles to gusset plates may be used in place of the bolted connections shown. Details shall be shown on shop drawings.

Field connections shall be made with 7/8-inch diameter, AASHTO M 164 high-strength bolts, unless otherwise shown.

Temporary or permanent attachments or devices that are not shown on the Plans as part of the structure shall not be welded to the structural steel members during the fabrication and construction process.

The cost of swedge bolts shall be included in the total cost of structural steel.

5. **Marking and Shipping.** Each member shall be painted or marked with an erection mark for identification, and an erection diagram shall be furnished showing the erection marks. Bolts of one length and diameter, and loose nuts and washers of each size shall be packed separately. Pins, small parts, small packages of bolts, washers, and nuts shall be shipped in suitable containers. A list and description of the material shall be plainly marked on the outside of each container. The loading, transporting, unloading, and storing of structural material shall be conducted so the metal is kept clean without stressing, deforming, or damaging the structural members.

Long steel members shall be handled by placing saddles at approximately the quarter points and during storing and shipping, blocking shall be placed at intervals that prevents sag and distortion. Rolled beams and built-up plate girders shall be stored, shipped, and handled in a vertical position.

6. **Shop Painting.** All required painting shall meet Section 630.
7. **Blast Cleaning of Unpainted Steel.** After fabrication with AASHTO 270 Grade 50 W steel for unpainted applications, the exterior faces of outside beams or girders (including stiffeners and flanges) and other steel readily exposed to view shall be blast cleaned as specified in the Steel Structures Painting Council Surface Preparation Specification "No. 6 Commercial Blast Cleaning," SSPC-SP 6. A corrosion inhibitor shall not be used.

Blast cleaning shall be included in the Contract Price Bid for the structural steel.

- D. **Shop Welding.** Shop welding shall meet the latest AASHTO/AWS D 1.5 Bridge Welding Code except as changed by this Specification. The electroslag and electrogas welding processes shall not be used for welding bridge members. Flange-to-web welds and shop welded splices in flanges or webs shall be performed using the automatic submerged arc and welding process.

1. **Qualification of Welders, Welding Operators, and Tackers.** As specified in Section 105.06 D. for all welding applications
2. **Built-up Plate Girders.** Web plates of built up beams and girders shall be cut to the prescribed camber with allowance for shrinkage due to cutting and welding.

All shop butt welds in the flange plates shall be made before final fitting and welding into the girders.

3. **Nondestructive Testing.** All nondestructive testing (NDT) of welds required by the latest AASHTO/AWS D 1.5 Bridge Welding Code and by Sec-

tions 616.03 D.4 and 616.03 D.5 of the *North Dakota Department of Transportation Standard Specifications*, shall be the responsibility of the Contractor.

Performance of NDT shall be done by trained personnel under the observation of the Engineer. The trained personnel shall have a minimum qualification as an American Society for Nondestructive Testing (ASNT) NDT Level II operator and two years experience at that level. A written report of all NDT shall be submitted to the Engineer along with material certification documenting compliance of the welds with contract requirements.

The cost of all NDT shall be included in the bid price for "Structural Steel."

Methods of nondestructive testing, in addition to those specified, may be used for examination of weld passes or complete welds.

The Department may examine weld areas not designated in the Contract.

4. **Radiographic and Ultrasonic Inspection.** Groove welds in main members of built up girder structures shall be inspected by radiographic or ultrasonic testing as follows:
 - a. All tension splices and all splices subject to reversals of stress shall be completely inspected.
 - b. On girder and beam web splices, only 1/6 of the web depth beginning at the point or points of maximum tension and 25 percent of the remainder of the web depth need be tested.
 - c. All compression flange splices shall be inspected.

Welds shall be tested after grinding.

Repaired welds shall be retested.

5. **Magnetic Particle Inspection.** At least 1 foot of every 10-foot length of weld and 1 foot of each weld less than 10 feet in length of longitudinal beam or girder web butt splices and fillet welds in main members, including the end connections, shall be tested by the magnetic particle inspection method. Tests shall be made at random locations in the members so as to be typical for each size of weld and type of joint.

If rejectable discontinuities are found in any test length of weld, the full length of the weld or 5 feet on either side of the test length, whichever is less, shall be repaired.

Welds shall be retested after repairs are made. Retesting shall include the repaired area plus at least 2 inches on each side of the repaired area.

E. **Erection.** The structure shall be erected as follows:

1. **Handling and Storing Materials.** Stored materials shall be kept clean and properly drained. Steel shall be stored above ground on platforms, skids or

other supports. Girders, beams, and long members such as columns and chords shall be supported to prevent damage from deflection. Girder sections shall be handled with beam clamps or other approved devices and wire rope slings shall not be used. On an erection contract, the Contractor shall check the material received against the shipping lists and promptly report in writing any shortages or damages. The Contractor shall be responsible for the loss of or damage to any material while in the Contractor's possession.

AASHTO 270 Grade 50 W steel to be used in unpainted applications shall be stored above ground on platforms, skids, or other supports. The steel shall be kept clean and free of all foreign materials such as grease, concrete spatter, chalk or crayon marks, dirt, or any foreign matter that may affect the metal's natural oxidation. Temporary protection shall be required during concrete operations and all operations that may affect uniform natural oxidation. Loading, transporting, and unloading of steel shall be conducted without surface damage and metal deformation.

2. **Falsework, Methods, and Equipment.** The falsework shall be designed, constructed, and maintained to support all loads. If required, the Contractor shall prepare and submit to the Engineer for approval, plans for falsework or for changes in an existing structure necessary for maintaining traffic. The submittal process shall be as specified in Section 616.03 A.
3. **Assembling Steel.** Parts shall be accurately assembled by the match marks on the shop drawings. Material shall be handled so parts are not bent, broken, or damaged. Bolts or nuts with rusted or damaged threads shall not be used. Hammering which damages or distorts the members shall not be permitted. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before members are assembled. Splice points in beam or girder spans shall be brought to proper elevation and supported in position before the fasteners are tightened. High strength bolts shall be assembled according to Section 616.03 C.3.
4. **Straightening Bent Material.** Bent members shall be returned to the fabricator for repair or replacement. Bends in main structural members shall not be straightened in the field without written permission of the Engineer.

Straightening of bent members shall be done without producing embrittlement, fracture, or damage. All material shall be straightened cold. Plated, galvanized, enameled, heat treated or cold drawn steel and copper alloys, malleable iron, tempered aluminum, or similar metals shall not be heated. Bent members that cannot be satisfactorily straightened cold shall be returned to the fabricator for repair or replacement.

Mild steel and structural grade steel may be heated when authorized in writing by the Engineer. The temperature of the heated area shall not exceed 1,200°F. (a dull red) as controlled by temperature indicating crayons, liquids, or bimetal thermometers.

5. **Field Painting.** Structural steel shall be painted according to Section 630.
6. **Field Welding.** As specified in Section 105.06 D.
7. **Removal of Rust Stains.** When AASHTO 270 Grade 50 W steel is erected in unpainted condition, all rust stains on the substructure units after complet-

ing all steel and concrete work shall be removed with a concrete rust stain remover. All areas receiving applications of rust stain remover shall be flushed with water.

Substructure units may be protected with reinforced polyethylene or similar material which shall be left in place to prevent staining until the superstructure is completed.

616.04 METHOD OF MEASUREMENT.

A. **General.** Structural metals placed in bridges or other structures will be measured by weight, length, area, or unit complete and in place.

The Contractor shall furnish calculated weights and measurements in duplicate to the Engineer for review and determination of final quantities.

Only accepted work will be measured for payment. Dimensions used will be those shown on the Plans, the approved shop drawings, or as authorized by the Engineer.

B. **Measurement by Weight.** Measurement by weight will be by the Pound. The quantity paid for will be the total weight, determined as specified. All castings and miscellaneous metal parts will be measured and paid for as Structural Steel. The following pounds per cubic foot of metal will be used as the basis of computation:

Aluminum, Cast or Wrought	173.0
Brass	534.0
Bronze, Cast	536.0
Bronze, Wrought	555.0
Copper, Sheet	558.0
Iron, Cast	445.0
Iron, Malleable	470.0
Lead, Sheet & Plate	707.0
Steel (all kinds)	490.0
Zinc, Sheet	450.0

1. **Structural Steel and Wrought Metals.** The weight of all permanent bolts 6 inches or less in length, thin nuts, field shims, ring fills, shop and field welds, shop and field painting, galvanizing, metallizing, and all other incidental metal items for which no direct weight measurement is made will not be measured or paid for and will be included in the Contract Price Bid for Structural Steel. Except as provided, the weight will be computed from dimensions shown on the Plans, the approved shop drawings, or as authorized by the Engineer. Deductions will not be made for cuts, copes, bevels, or open holes; and allowance will not be made for mill overruns.

2. **Structural Plates.** The weight of rectangular plates (such as web plates, cover plates, batten plates, etc.) will be computed on the basis of the net length and width shown on the Plans. Allowance will not be made for planed or sheared edges.

The weight of each plate or irregular shape will be computed on the basis of the dimensions of the smallest rectangular plate from which it can be cut. When plates are machine finished, the dimension of the plates will be the

maximum machine finished dimension plus 1/8 inch for each finished surface.

3. **Structural Shapes and Bars.** The weight of all bars and structural shapes with square ends will be computed on the basis of the net section and the length as shown on the Plans.

Identical structural shapes, less than 5 feet long, with mitered ends will be considered multiple cut. Their total weight will be computed as the weight of the shortest parent section from which they can be cut, provided the length of the parent section is not be more than 30 feet.

Except as provided above, the weight of each structural shape with mitered ends will be computed on the basis of the section and overall length measured parallel to the axis of the shape.

4. **Pins and Rollers.** The parent section for forged segmental rollers will be considered square in section, and of the same length, width, and thickness as the finished roller.

The weight of hot-rolled bar steel pins and rollers will be computed on the basis of the length shown on the Plans and on the basis of a diameter 1/4 inch greater than that of the finished pin or roller. The weight of cold finished bar steel pins and rollers will be computed on the basis of the net length and diameter shown on the Plans.

5. **Bolts and Tie Rods.** The weight of bolts over 6 inches long and tie rods including necessary nuts and washers used for connecting structural steel parts will be computed from the nominal weights as given in the current handbook of the American Institute of Steel Construction. These weights will be included in the weight of "Structural Steel."

6. **Castings.** The weight of each casting will be computed from the net dimensions shown on the approved shop drawings, with an addition of 10 percent to compensate for fillets and overruns. Wherever machine-finished surfaces are required, an allowance of 1/8 inch in thickness will be made for each surface so finished. When cored holes are shown on the Plans, a deduction will be made for the full size of the core.

7. **Pipe.** The weight will be computed from the dimensions shown on the Plans and the nominal weights of the pipe and fittings.

8. **Sheet Metal.** The weight will be computed from the smallest rectangular area from which the developed surface can be cut.

- C. **Lump Sum Basis.** When Structural Steel is measured and paid for on a "Lump Sum" basis, it includes all Structural Steel required under this Section and will not be modified unless design Plan changes are ordered by the Engineer. The following conditions will apply to the lump sum basis:

1. The estimated weight of Structural Steel computed according to Section 616.04 B will be shown on the Plans. If any change in design is made which effects the weight of material furnished, payment for the additional Structural

Steel required as a result of the change will be made at a unit price per pound. This unit price will be obtained by dividing the Lump Sum bid for Structural Steel by the total estimated weight of Structural Steel shown on the Plans. Reduction in weight due to changes in design will be made at the same calculated rate, and will be deducted from payments due.

2. Prospective Bidders shall verify the estimated weight of Structural Steel before submitting a bid. Adjustments other than for authorized changes will not be made in the Lump Sum bid even though actual weight may deviate from the stated estimated weight.

616.05 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price as follows:

Pay Item	Pay Unit
Structural Carbon Steel AASHTO 270 Grade 36	Pounds
High Strength Low-Alloy Columbium Vanadium Steel AASHTO 270 Grade 50	Pounds
High Strength Low-Alloy Structural Steel with 50,000 psi Minimum Yield Point to 4 inch Thick AASHTO 270 Grade 50 W	Pounds
Castings	Pounds
Pipe	Pounds
Sheet Metal	Pounds
Structural Steel	Lump Sum

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

SECTION 618 TIMBER STRUCTURES

618.01 DESCRIPTION.

This work consists of constructing timber structures.

618.02 MATERIALS.

Materials shall meet the following:

Item	Section
Timber	844.01
Timber Connectors	844.02 A
Timber Preservatives	846
Timber Treatment	846
Hardware	844.02 B
Paint	852

Structural glued laminated timber shall meet U.S. Product Standard PS 56-73 for Structural Glued Laminated Timber. The term "structural glued laminated timber" as

employed in PS 56-73 is an engineered, stress-rated product of a timber laminating plant, comprising assemblies of suitably selected and prepared wood laminations securely bonded together with adhesives. The grain of all laminations is approximately parallel longitudinally. The separate laminations may not exceed 2 inches (.051 m) in net thickness. They may be comprised of pieces which are end-joined to form any length, or of pieces placed or glued edge to edge to make wider ones, or of pieces bent to curved form during gluing.

618.03 CONSTRUCTION REQUIREMENTS.

- A. **General.** All timber shall be stored to shed water and to prevent distortion and warping. Untreated timber shall be open stacked. Treated timber shall be closed stacked.

All timber shall be handled without splitting or damaging the surface and edges. Treated timber shall be handled without breaking through the surface penetrated by the treatment.

All cutting, framing, and boring of treated timber shall be done before treatment.

Timber to be included in the finished structure shall not be used for temporary falsework, staging, etc.

Temporary bolting, spiking, or nailing shall not be used on treated timber.

- B. **Fabrication.** All lumber and timber shall be accurately cut and framed to a close fit so the joints have an even bearing over the entire contact surfaces. Joints shall not be shimmed nor shall open joints be used.

The size of holes bored in untreated timber shall be as follows:

1. Round drift bolts or dowels - 1/16 inch less in diameter than the size of the drift bolt or dowel.
2. Square drift bolts or dowels - diameter of the hole equal to the side dimension of the drift bolt or dowel.
3. Bolts - same diameter as the bolt.
4. Rods - 1/16 inch greater than the diameter of the rod.
5. Lag screw shank - same as the nominal size of the lag screw.
6. Lag screw thread - same diameter as the body of the screw at the base of the thread.

All holes in timber before treatment shall be 1/16 inch larger than specified above.

All cuts or abrasions in treated timber, after having been carefully trimmed, shall be given three applications of hot creosote oil and covered with roofing pitch.

All holes in untreated timber (except handrails) and treated timber shall be treated with hot creosote oil so all of the hole surface is thoroughly coated with the oil.

Treating shall be done before inserting or driving bolts, lag screws, rods, and drift pins. All unfilled holes, after being treated with creosote oil, shall be filled with tight-fitting creosoted plugs.

All stringers shall be sized to a uniform depth at bearings. Dapping or sizing shall be done on the better edge of the piece, placing this edge downward.

Bolts shall be the sizes specified and long enough to extend completely through the nuts. Extra washers shall not be used on bolts that are too long, and galvanized bolts shall not be rethreaded. Bolts, dowels, etc. which are not galvanized shall be given two coats of iron oxide paint before installation.

Nails and spikes shall be driven so the heads are flush with the surface of the wood without leaving hammer marks.

Grooves for split ring timber connectors shall be accurately cut. Other timber connectors shall be embedded in the timber by pressure alone. Mauls, sledges, etc. for embedding the connectors shall not be used.

- C. **Excavation.** All excavation for placing timber abutments and mud sills, concrete pedestals for bents, and bents shall be done before the piles are driven. This excavation will not be measured for payment.
- D. **Erection.** Piles in any one bent shall be selected by size to avoid bending or distortion of the sway bracing. Cutoffs shall be accurately made to assure full bearing between the caps and piles of a bent. Tops of piles shall not be shimmed.

Mud sills for framed bents shall be firmly and evenly bedded to solid bearing and tamped in place.

Concrete pedestals to support framed bents shall be smoothly finished so the sills or posts have an even bearing.

Sills shall have true and even bearing on mud sills, piles, or pedestals. All earth shall be removed from contact with sills so there is free air circulation.

Posts shall be framed true and shall have full bearing on both sills and caps.

Timber caps shall be placed to secure an even and uniform bearing over the tops of the supporting posts or piles, and to secure an even alignment of their ends.

Planks in floors shall be securely spiked to each stringer with two 6-inch spikes for 3-inch plank, and two 7-inch spikes for 4-inch plank. Planks in walls shall be securely spiked to each pile or post with two 7-inch spikes for 3-inch plank.

In 2-inch laminated floors, each 2-inch strip shall be nailed to the adjacent strip with 40 d spikes placed 24 inches center to center and staggered 8 inches with the spikes in the adjacent strip. In 3-inch laminated floors, each 3-inch strip shall be nailed to the adjacent strip with 50 d spikes spaced 18 inches center-to-center and staggered 9 inches with the spikes in the adjacent strip. In addition, each strip shall be toe-nailed to every second stringer with a 16 d nail, the nailing of successive strips being staggered so the spacing of the nails along each stringer shall be two times the thickness of one strip.

Floor plank and strips less than 8 feet in length shall not be used. Where it is necessary to use more than one length of floor plank or strip for transverse flooring, the joints between ends of plank or strip shall be made over a joist or stringer. Splices shall be staggered and shall not occur over a common joist or stringer closer than every fourth plank or strip.

All backing plank shall be nailed to each stringer or pile with two 7-inch spikes.

If splitting is observed while nailing superstructure or substructure elements, a small pilot hole shall be bored for each spike.

- E. **Salvaging Timber for Reuse.** All timber to be reused from an existing bridge shall be removed, cleaned of all nails, spikes, bolts and foreign material, and stored without damage. Timber material that is damaged or lost shall be replaced at the Contractor's expense.

All bolt and nail holes in reused timber shall be treated with creosote, and unused holes filled with creosoted plugs. Cuts and abrasions in reused timber shall be carefully trimmed and given three applications of hot creosote and covered with hot tar.

- F. **Painting.** Timber shall not be painted.
- G. **Backfilling.** Backfilling shall meet Section 210.

618.04 METHOD OF MEASUREMENT.

Quantities of various items in completed and accepted structures will be measured for payment according to the Contract for the pay items, and in the terms of the prescribed units for those items. Only accepted work will be included and the dimensions will be those shown or authorized in writing by the Engineer.

On timber bridges, all metal items and incidental non-metallic items will not be measured and paid for directly, but will be included in the Contract prices for the pay items listed in the Contract.

- A. **Untreated and Treated Timber.** The unit of measure for Untreated Timber and Treated Timber will be the Thousand Feet Board Measure (MBM), and the amount to be paid for will be the actual number of (MBM) in the completed and accepted structure computed as follows: actual sizes of full sawn timber and nominal sizes of dressed timber will be used. The length used will be the nearest commercial (multiples of 2 feet) lengths from which the representative pieces can be cut; except for pieces less than 10 feet in length, the lengths used will be the nearest commercial lengths, not exceeding 24 feet, from which the pieces can be cut in multiples.
- B. **Glued Laminated Stringers and Glued Laminated Deck Panels.** The unit of measure for Glued Laminated Stringers and Glued Laminated Deck Panels will be the number, "Each," of the size and length designated in the Contract.
- C. **Treated Timber Structure and Untreated Timber Structure.** When the Proposal Form stipulates payment will be made for Treated Timber Structure and Un-

treated Timber Structure on a Lump Sum basis, all labor, materials, equipment, etc., except piling, necessary to complete the work shall be included in the Lump Sum bid. Piling will be measured and paid for as specified in Section 622.

618.05 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price as follows:

Pay Item	Pay Unit
Untreated Timber	MBM
Treated Timber	MBM
Glued Laminated Stringers	Each
Glued Laminated Deck Panels	Each
Treated Timber Structure	Lump Sum
Untreated Timber Structure	Lump Sum

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

SECTION 622 PILING

622.01 DESCRIPTION.

This work consists of furnishing and driving piles, including test piles.

622.02 MATERIALS.

Material shall meet the following:

Item	Section
Untreated Timber Piling	840.02
Treated Timber Piling	840.02
Steel Piling	840.01 A
Steel-Encased Concrete Piling	840.01 B
Steel Sheet Piling	840.03 A
Corrugated Steel Sheet Piling	840.03 B
Creosote Preservative Treatment for Timber	846
Paint	852

622.03 CONSTRUCTION REQUIREMENTS.

A. Test Piles.

1. **General.** The Contractor shall furnish and drive test piles of the type, size, number, length, and at the location specified.

Test piles shall be driven using the same type and size of hammer to be used to drive regular foundation piles to final bearing.

Test piles shall not be driven until excavation to the elevation of the bottom of the footing has been completed, or a hole larger than the diameter of the pile is prebored down to the elevation of the bottom of the footing in which the pile is driven.

Test piles shall be driven to a minimum of 125 percent of the design-bearing load or as required for a load test.

When a timber test pile is driven to Plan length and does not achieve 125 percent of design bearing load, the Engineer will determine if an additional, longer test pile is required.

A follower to drive test piles shall not be used.

The lengths and number of piling shown on the Plans are estimated for bidding purposes and the length of the pile to be furnished will be determined by the Engineer from the results of driving test piles.

2. **Pile Formulas.** The formulas shown shall be applied when computing the bearing value by pile penetration for all piles. Penetration measurements to determine pile bearing values shall not be made when pile heads are damaged by burring, corrugating, or crushing or immediately after fresh cushioning material has been inserted over the head of the pile. In the absence of load tests, the safe bearing value of piles shall be determined by the following formulas unless otherwise specified:

$$P = \frac{3.5 WH}{S + 0.4} \times \frac{W + 0.2 M}{W + M} \dots\dots\dots \text{For gravity hammers}$$

$$P = \frac{3.5 E}{S + 0.2} \times \frac{W + 0.2 M}{W + M} \dots\dots\dots \begin{array}{l} \text{For double acting or} \\ \text{single acting steam} \\ \text{or air hammers and} \\ \text{diesel hammers} \end{array}$$

Where:

- P = Safe bearing value, in pounds.
W = Weight of striking parts (ram), in pounds.
H = Height of free fall of ram, in feet.
M = Weight of parts being driven, in pounds. Includes pile weight, anvil (if any), driving cap, etc.
E = Energy per blow, in foot-pounds.
S = Average penetration of pile in inches per blow for last five blows for gravity hammer and the last ten blows for steam, air, or diesel hammer.

The preceding formulas are applicable only when:

- a. The gravity hammer has a free fall.
- b. The head of the pile is free from broomed or crushed fiber.
- c. The penetration of the pile is at a reasonably uniform rate.
- d. There is no noticeable bounce after the blow. When there is a noticeable bounce, twice the height of the bounce shall be deducted from "H" to determine the value of "H" in the formula.

The bearing value of timber piles, as determined from formulas, shall be considered effective only when they are less than the safe working stresses for the materials of which the piles are made. When water jets are used with the driving, the bearing value shall be determined by the formulas from the results of driving after the jets have been withdrawn.

- B. Pile Driving.** Piling shall not be driven unless the Engineer is present and was given at least 24 hours advance notice of any pile driving operations.

Pile shall not be driven within 80 feet of concrete which has cured less than 3 days, or a greater distance if determined necessary by the Engineer.

Before driving foundation piles, the excavation shall be completed to the bottom of the footing elevation.

Any excess excavation and voids remaining after pile driving is completed shall be backfilled and compacted to the bottom of the footing elevation with foundation fill, at the Contractor's expense.

Timber piles may be sharpened at the tip.

A steel head block or cap fitted to the pile head shall be used to prevent damage to the pile head. The head block or cap shall be provided with a shock block or cushion. Where necessary, bands shall be used to prevent splitting in the body of timber pile.

Pile driver leads shall be used for all types of hammers. They shall allow free movement of the hammer and rigidly hold the pile in correct alignment during the driving operation.

The driving of piling with followers is not permitted.

When specified penetration cannot be obtained without damaging the pile, the Engineer may approve the use of jetting, preboring, or spudding to secure the required penetration. The final driving shall be with the hammer for determining bearing.

When pilings are driven through a constructed embankment, having a thickness of 5 feet or more below the bottom of footing, the embankment shall be prebored for each pile. All pilot holes not completely filled by piles shall be backfilled with sand or fine gravel before the substructure is built.

Sawing or cutting the body of a pile to assist in springing it to proper location is not permitted. If a pile vibrates excessively or shows signs of buckling during driving, it shall be braced or guyed to assure satisfactory results.

Damaged piles shall be replaced or corrected.

Sections of piling that become part of the structure shall not be reduced in cross-section by drilling or burning holes for handling purposes. Any section of piling that is drilled or burned shall be removed and not incorporated into the structure.

During the driving of foundation piling, the pile shall not deviate from the vertical or from the specified batter more than 1/2 inch per foot of pile length. After driving, the center of the pile at the cutoff shall not be more than 6 inches from Plan location. Piling that are not driven to these tolerances will be rejected.

During driving, the piles for trestle bents shall not deviate from the vertical or from the specified batter more than 1/4 inch per foot of pile length. After driving, the piles shall support the cap in its proper position with full bearing on each pile. Piling that are not driven to these tolerances will be rejected.

Steel and precast concrete trestle piles shall be driven between guides rigidly held in position during the driving. The guides shall be securely braced to adjacent piling or to temporary piling.

Steel-encased concrete piles shall be driven using a steel combination driving head and pilot of the proper size to ensure properly distributed hammer blows on the pile shells to prevent damage. Clearance between the pilot ring and the pile shell shall not exceed 1/4 inch. A cushion block of timber shall be used between the hammer and the driving head. Dimensions of the pile shell shall be as specified on the Plans. The end enclosure plate shall be circular, not less than 3/4 inch in thickness, and not be larger in diameter than the outside diameter of the pile shell.

Adequate lighting shall be provided for inspection of the pile shell throughout its entire length. Improperly driven, broken, and defective pile that is not watertight, shows bends, kinks, or other deformations shall be removed and replaced or repaired by and at the Contractor's expense. The tops of pile shells that are not filled with concrete immediately after driving shall be sealed temporarily to prevent the entrance of water or foreign substances.

All pile shells for any one bent, pier, or abutment shall be completely driven before any concrete is placed in the pile shells. If this is not practical, the remaining pile shells shall not be driven until the concrete in all pile shells attains a compressive strength of 2,000 pounds psi.

The pile driving operations are not considered complete until all heaved piles have been redriven.

C. **Pile Hammers.**

1. **General.** The pile hammer shall meet the requirements of energy and ram weight as specified unless the Contractor can prove with a load test that piling driven with a smaller energy hammer holds, without failing, a load at least 2-1/2 times the specified bearing. This proof test load shall be at the Contractor's expense. If not specified, the minimum foot-pounds of energy per blow developed by steam, diesel, or air hammer shall not be less than 10,000 foot-pounds nor less than two times the weight of the pile in pounds, whichever is greater. A steam, diesel, or air hammer shall be operated at its rated number of blows per minute while determining bearing.

2. **Gravity Hammer.** The minimum weight of a gravity or “drop” hammer for driving steel or steel-encased concrete piles shall not be less than 4,000 pounds nor less than the combined weight of the pile and driving head, whichever is greater. The minimum weight of a gravity or “drop” hammer for driving all other piles shall not be less than 3,000 pounds nor less than the weight of the pile and driving head, whichever is the greater. The fall of the hammer shall be regulated to avoid damage to the pile and shall not exceed 15 feet for timber and steel piling, or 10 feet for steel-encased concrete piling.
3. **Diesel Hammer.** When using a diesel hammer, the maximum foot-pounds of energy per blow used in computing the driving bearing of individual piles shall be the manufacturer’s rated energy with the following applicable reductions:
 - a. When using open top type diesel hammers, a reduction in the rated energy shall be made if the hammer does not maintain the minimum measured stroke. This reduction shall be based on the percentage of the reduced stroke.
 - b. When using a closed top type diesel hammer, the maximum energy shall be the rated energy subject to the condition that the Contractor shall furnish an appropriate readable gauge and chart to measure the bounce chamber pressure and resulting hammer output. If no instrument is provided, an independent testing firm shall be furnished to perform dynamic testing on the piling. The testing shall be at the Contractor’s expense.
4. **Air Hammer.** When using an air (or steam) hammer, the maximum foot-pounds of energy per blow for computing the driving bearing of individual piles shall be the accepted manufacturer’s energy rating subject to the following condition:

When using double-acting air (or steam) hammers, the manufacturer’s rated energy is applicable only when the required pressure (mean effective) is properly delivered to the hammer as specified by the manufacturer. When pressure at the hammer is below that specified, the energy shall be adjusted downward according to $E = H(W + AP)$.

Where:

- E = Energy per blow, in foot-pounds.
- H = Height of fall, in feet.
- W = Weight of striking parts (ram), in pounds.
- A = Area of piston, in square inches.
- P = Steam (or air) pressure at the hammer in pounds per square inch.

When the use of an air (or steam) hammer is proposed, the Engineer shall be furnished a descriptive catalog showing the essential Specifications necessary to determine hammer output.

- D. **Bearing Value.** The design load of foundation piles in a substructure unit and the minimum penetration will be shown on the Plans.

Piling shall be driven to obtain the minimum penetration and design load, or to a penetration and bearing determined by the Engineer. Bearing value shall be determined by the formula specified which is applicable to the type of hammer used.

If the Engineer determines that it is necessary to drive piles through thin layers of hard material underlaid with soft material, the pile driving forces through the thin layers may exceed the anticipated driving forces needed to obtain the specified bearing.

E. Cutoff and Treatment of Pile Heads.

1. **Timber Piles.** The tops of all timber piling shall be cut off to the planes and elevations specified. Piles which support timber caps or sills shall be sawed to the plane of the superimposed structure. The head of the cutoff pile shall be sound, undamaged wood.

All cuts and abrasions in treated timber piles shall be given three applications of hot creosote oil and covered with roofing pitch. All holes bored in treated timber piles shall be given two applications of hot creosote before the bolts are placed.

The heads of treated timber piles which are imbedded in concrete shall be given three heavy applications of hot creosote oil and a thick layer of roofing pitch.

The heads of all cut off treated timber piles for trestle bents, wing piles, and foundation piles for timber bents shall receive the following treatment:

A ring of metal shall be provided near the edge of the top of the pile. One inch of creosote oil shall be placed inside the ring and on top of the pile for 36 hours to assure adequate penetration of the end fibers. The end of the pile shall be covered with a thick layer of roofing pitch. A circular cap of aluminum, not lighter than 25 U.S. gauge and not smaller than 6 inches larger than the diameter of the pile, shall be neatly bent and crimped around the sides of the pile. The lower edges of the aluminum cap shall be covered with a strip of aluminum (at least 2 inches wide) of the same grade and thickness, using 2-inch aluminum nails for fastening.

2. **Steel Piling and Steel-Encased Concrete Piling.** Steel piles shall be cut off at the established elevation. When steel cap plates are specified, the cutoff shall be at 90 degrees to the axis of the pile and shall be cut true to provide full bearing over the entire cross section of the pile.

Final cutoffs shall be approximately 90 degrees to the axis of the pile.

F. Extensions.

1. **Timber Piling.** Full length timber piles shall be used.
2. **Steel Piling and Steel-Encased Concrete Piling.** When it is necessary to increase the length of steel piles and steel-encased concrete piles, an additional length may be spliced to the original length. The sections shall be of identical cross-section. Steel piling and steel-encased concrete piling shall be spliced by welding according to Plan details.

Splices shall provide and maintain true alignment and position of the component parts of the pile during and after installation. Field splices in steel pile shells shall develop the full strength of the shell and shall be watertight.

The minimum lengths of pile which may be spliced by welding shall not be less than 5 feet. A shorter length may be used to make the last splice below cutoff.

Steel piling sections spliced together by welding while in horizontal position shall not exceed the following variation in straightness in inches:

$$\frac{1/8 \text{ inch} \times \text{number of feet of total length}}{10}$$

Only qualified welders shall splice steel piling and steel-encased piling. For splices made with the pile in the horizontal position, the welder shall be qualified for position 3G (vertical groove) and 4F (overhead fillet). For splicing vertical reinforced concrete pile shells and vertical steel H-piling without reinforcing plates, the welder shall be qualified for position 2G (horizontal groove). For splicing vertical steel H-piling with reinforcing plates, the welder shall be qualified for position 2G (horizontal groove), 3F (vertical fillet), and 4F (overhead fillet). The cost of testing and certification shall be at the Contractor's expense. Test welds shall be witnessed by a representative of either the Department or an independent testing agency.

A copy of the welder's qualification test certificate shall be subject to approval by the Engineer before the welder performs any welding. Approval will be for one year from the date of qualification. Approval of the welder's certification may be requested for additional periods of one year, up to a maximum of three one-year extensions, if the welder has been actively engaged at welding in the required positions within the previous six months. The Department has the right to require a requalification test at any time.

Steel may be welded up to and including 3/4-inch thickness without the use of preheat when the base metal temperature is not lower than 50°F. If the base metal temperature is lower than 50°F, the base metal shall be heated to at least 50°F. and the temperature maintained during welding.

When the air temperature approaches 0°F., welding shall not be done until protection has been provided which keeps the air temperature surrounding the work above 0°F.

When preheating the base metal is required, it shall be performed so the surfaces of the parts on which metal is being deposited, within three inches of the point of welding both laterally and in advance of the welding, are at or above the 50°F. temperature specified. Base metal shall not be preheated to more than 400°F.

No welding shall be done in rain, snow, or sleet, or high wind without adequate protection.

Electrodes shall meet "Carbon Steel Covered Arc Welding Electrodes" AWS-A5.1, Classification E6010, E6011, or E7018.

Three certified copies of test reports shall be furnished of all pertinent required tests of AWS-A5.1 made on electrodes of the same class, size, and brand; and which were manufactured by the same process and with the same materials as the electrodes furnished. The tests may have been for process qualification or quality control and shall have been made within one year before manufacture of the electrodes furnished. Three copies of the manufacturer's certification shall be furnished that the process and material requirements were the same for manufacturing the tested electrodes and the furnished electrodes.

All electrodes while in the original unbroken package shall be stored in a warm, dry room or other weatherproof location. Open packages of electrodes shall be immediately stored in a holding oven at a temperature of at least 250°F. Electrodes that are removed from the container or holding oven for welding, shall not be exposed to the atmosphere for more than four hours without redrying for two hours at between 450°F. and 500°F. Electrodes shall not be redried more than once. Electrodes that have been wet shall not be used.

G. **Steel-Encased Concrete Piling.**

1. **Filling with Concrete.** Concrete shall not be placed in pile shells containing water or any foreign substance.

The pile shall be filled with Class AE Concrete meeting Section 802. The concrete shall be deposited in one continuous operation and the rate of depositing shall be moderated to avoid formation of air pockets.

The concrete footing or cap shall not be placed until at least two hours after all piles within the pile group are filled with concrete.

2. **Reinforcement.** Reinforcement for the steel-encased piles shall be used if specified. Reinforcement shall be a rigidly tied cage. Reinforcement shall be placed at a clear distance of one inch from the face of the pile shell, and shall be provided with spacers to ensure the specified clearance for the bars. Reinforcement shall meet Section 612. Concrete shall be placed in the shell to a point approximately two feet below the bottom elevation of the reinforcing steel assembly before placing the reinforcing steel assembly in the pile shell.

- H. **Painting.** Parts of steel piles and steel-encased concrete piles exposed to view in the finished structure shall be painted according to Section 630.03 D.3. Portions of those piles extending above a level of three feet below the final ground surface elevation shall be painted. Galvanized piling may be used in lieu of painting.

622.04 STEEL AND CORRUGATED STEEL SHEET PILES.

The sheet piles shall be driven with a hammer of sufficient weight and driving capacity to overcome the inertia of the pile and the resistance of the soil, without peening or upsetting the pile ends. A driving cap made expressly for the type of sheeting being driven shall be used.

Any sheet pile broken because of defects or improper driving, driven out of proper position, or driven below Plan cutoff shall be removed and replaced at the Contractor's expense.

Damaged galvanized sheet piling surfaces shall be repaired by applying a paste of approved zinc powder and flux with a minimum amount of water. The surface to be coated shall be heated sufficiently with a torch so all metallics in the paste are melted when applied. Repair shall be at the Contractor's expense.

622.05 METHOD OF MEASUREMENT.

- A. **Timber, Steel, and Steel-Encased Piling.** The footage of Timber, Steel, and Steel-Encased Piles to be paid for will be the actual number of Linear Feet of piling left in place in the completed work as accepted by the Engineer. Concrete and reinforcing steel used in Steel-Encased Concrete Piling will not be measured as separate items. All cutoffs become the Contractor's property.
- B. **Test Piles.** Test Piles will be measured either by the number of Test Piles actually furnished, driven, and accepted by the Engineer; or by the number of Linear Feet of Test Pile specified, even if a lesser footage is actually furnished, driven and accepted by the Engineer. The Plans will indicate which type of measurement is to be used. Piling measured for as Test Pile will not be included in the measurement of pay footage of Piling. All cutoffs become the Contractor's property.
- C. **Corrugated Steel and Steel Sheet Piling.** The unit of measure for Corrugated Steel and Steel Sheet Piling will be the "Square Foot," and the quantity to be paid for will be the number of Square Feet of piling actually remaining in the completed structure and accepted. The area in square feet will be obtained by multiplying the nominal width (distance center to center of joint) by the total length of the Sheet Piles remaining in place after the cutoff.
- D. **Steel Pile Splices.** The unit of measure for Steel Pile Splices will be one pile splice which includes labor, equipment, materials, preparation of weld surfaces, and welding necessary to complete the splice. The quantity to be measured will be the number of pile splices determined as follows:

Steel Pile Splices located within the pile length called for or the length determined by the Engineer will not be measured. If a Test Pile is not required, the number of splices to be measured for payment will be those located at or beyond the length specified necessary to increase the length of a pile incorporated into the structure over the length specified. If a Test Pile is required, the number of splices to be measured for payment will be those located at or beyond the length determined by the Engineer necessary to increase the length determined by the Engineer. Steel Pile Splices required to increase the lengths of Test Piles over the lengths shown on the Plans and located at or beyond the lengths shown on the Plans will be measured for payment.

622.06 BASIS OF PAYMENT.

- A. The linear feet or square feet of piling for each type of pile provided will be paid for at the Contract Unit Price except that the Unit Price for Timber Piling will be adjusted according to the following conditions:

When the Contractor is required to order individual Timber Pile lengths which are longer or shorter than the Plan length, the Contract Unit Price will be increased or decreased by the difference between the actual invoice cost of the piling ordered and the actual invoice cost of the Plan length piling.

No reduction in the Contract Unit Price will be made on piles shown to be 45 feet in length or less and ordered to a lesser length.

In all cases, the adjusted unit price will apply to the full length of pile remaining in place in the completed work and accepted by the Engineer.

Adjustment in Timber Piling prices will be made for each footing.

- B. Test pile measured as stated will be paid for at the Contract Unit Price for each type of Test Pile.
- C. When the final in-place quantity of each size of Steel or Steel-Encased Piling driven and accepted for payment varies from the original estimated quantity, the Contractor will be compensated for the difference in the two quantities as follows:
 - 1. When the final piling quantity of each size underruns the Plan quantity by more than 25 feet, the Contractor will receive 20 percent of the Contract Unit Price for the entire difference in quantities. Payment for the in-place and accepted piling will be at Contract Unit Price.
 - 2. When the final piling quantity of each size overruns the Plan quantity by more than 25 feet, the Contractor will receive the Contract Unit Price plus 10 percent for the excess over Plan quantity. Payment for Plan quantity of the in-place piling will be at Contract Unit Price.
 - 3. No adjustment will be made when the final in-place quantity of piling for each size varies from the original estimated quantity by 25 lineal feet or less.

Provisions of Section 104.03 B.2 will not be applied to piling quantities.

If it becomes necessary to drive Timber Piles of greater length than is shown, the additional length driven will be paid according to Section 104.03.

When it is necessary to drive Steel Test Piles or Steel-Encased Test Piles of greater length than that shown, the additional length driven will be paid for at the Contract Unit Price per foot for "Steel-Encased Concrete Piling" or "Steel Piling."

- D. Pile Cutoff is defined as the difference between the measured length of the piling furnished, but not exceeding the length specified, and the length actually driven and incorporated in the structure.
 - 1. Payment will be made for Pile Cutoff on Treated and Untreated Timber Piling under the following conditions:
 - a. Cutoff used in the work as piling will not be paid for as cutoff.
 - b. Payment for Pile Cutoff will be at the receipted invoice price delivered on the Project.
 - c. All Pile Cutoff not used in the work as piling will remain the property of and shall be disposed of by the Contractor.
 - 2. Payment will not be made for Pile Cutoff on Steel or Steel-Encased Concrete Piling.

- E. The accepted quantity of Steel Pile Splices will be paid for by the following method for each pile splice:
1. Steel H-Pile. Four times the Contract Bid Price per foot of regular foundation piling of the same size spliced.
 2. Steel-Encased Concrete Pile. Three times the Contract Bid Price per foot of regular foundation piling of the same size spliced.

SECTION 624 RAILINGS

624.01 DESCRIPTION.

This work consists of furnishing and installing metal railings for bridges, curbs, sidewalks, parapets, wingwalls, or retaining walls.

624.02 MATERIALS.

Materials shall meet the following:

Item	Section
Structural Steel	834.01
Miscellaneous Metals	834.02
Paint	852
Galvanizing	854
Ornamental Metal Railing	As shown on the Plans

624.03 CONSTRUCTION REQUIREMENTS.

Steel fabrication and erection shall meet Section 616.

Bolts with self-locking nuts shall be placed with the heads toward the roadway or walkway.

Welded joints shall be finished by grinding or filing to provide a neat appearance.

Steel railing shall be galvanized.

Aluminum railing shall be cleaned of all dirt and foreign matter, and polished to provide a uniform appearance.

624.04 METHOD OF MEASUREMENT.

The unit of measure for Railing will be the total number of Linear Feet of Railing in place and accepted, measured along the Railing centerline as specified.

When a separate Bid Item is not included for Railing, the Railing will be measured by the Pound or Lump Sum basis as specified for Structural Steel in Section 616.

624.05 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Prices as follows:

Pay Item	Pay Unit
Railing	Linear Feet

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

SECTION 626 COFFERDAMS

626.01 DESCRIPTION.

This work consists of designing, constructing, dewatering, maintaining, removing, and backfilling all cofferdams necessary for constructing footings.

Cofferdam shall designate any temporary or removable structure designed to hold the surrounding earth, water, or both out of the excavation. A cofferdam may be constructed of earth, timber, steel, concrete, or a combination of these. It includes earthen dikes, timber cribs, any type of sheet piling, and removable steel shells or any similar construction.

626.02 CONSTRUCTION REQUIREMENTS.

- A. **General.** Cofferdams for foundation construction shall be carried to adequate depths and heights. They shall be designed and constructed to be safe and as watertight as necessary for the proper performance of the work which must be done inside them. Interior dimensions shall give sufficient clearance for construction and exterior inspection of forms, and placement of pumping equipment.

Cofferdams which tilt or move laterally during the process of sinking shall be righted or enlarged to provide the necessary clearance at the Contractor's expense.

Cofferdams shall be constructed to protect green concrete against damage from a sudden rising of the stream and to prevent damage to the foundation by erosion. No timber or bracing which extends into the substructure shall be left in the substructure without approval of the Engineer.

- B. **Excavation.** Excavation inside the cofferdam that is within the limits defined in Section 210.04 A shall be paid for by the class of excavation designated on the

Plans. Other excavation costs inside the cofferdam but outside the limits defined in Section 210.04 A will be included in the bid item “Cofferdams.”

- C. **Removal of Cofferdams.** Cofferdams shall be removed when no longer needed. Excavation shall not be removed below the natural channel bottom outside the cofferdam to facilitate sheeting removal.

After the cofferdam is removed, Ordinary Backfill shall be used to fill the excavated area to the natural channel bottom. Ordinary Backfill shall be included in the bid item “Excavation.”

- D. **Seal Concrete.** Concrete foundation seals shall be constructed and paid for according to Section 602.
- E. **Pumping.** Pumping from the interior of any foundation enclosure shall not be permitted during placement of concrete, or for at least 24 hours after placement, unless it is done from a sump separated from the concrete work. Pumping to dewater a sealed cofferdam shall not begin until the seal has set sufficiently to withstand the hydrostatic pressure.

626.03 METHOD OF MEASUREMENT.

When the Proposal Form includes a quantity for Cofferdams, each Cofferdam will be measured as a unit. This unit shall include all Cofferdams required in the construction of any pier or abutment.

626.04 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price as follows:

Pay Item	Pay Unit
Cofferdams	Each

When the Cofferdam is installed, 70 percent of the Contract Unit Price will be paid. The remaining 30 percent will be paid when the Cofferdam is removed and disposed of.

Any modification of a Cofferdam made necessary by a change in Plans will be paid for according to Section 104.03.

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

**SECTION 630
PAINTING**

630.01 DESCRIPTION.

This work consists of furnishing all paints and paint materials; preparing surfaces to be painted; applying, protecting, and drying paint coatings; and protecting all traffic, ad-

jacent property, and the work itself against spatters or other damage due to painting operations.

The shop paint system for new structural steel shall consist of an inorganic zinc silicate primer and a compatible high-build, aliphatic polyurethane finish coat, both with the same manufacturer. After fabrication and before shipment, the primer and finish coat shall be applied to all surfaces except as specified.

The field applied system shall be an aluminum filled epoxy mastic primer and a compatible high-build, aliphatic polyurethane finish coat, both with the same manufacturer. This system is intended for rehabilitation painting of existing steel structures. It is also intended for coating field splices as well as touch-up of damaged areas of shop applied coats on new structural steel after erection.

630.02 MATERIALS.

- A. **Inorganic Zinc Silicate Primer.** The inorganic zinc silicate primer shall be a two-component self-curing type which, when mixed and applied by the manufacturer's instructions, cures without the use of a separate curing solution meets the requirements of AASHTO M 300, and has the following properties:
1. **Composition:** Zinc dust shall meet ASTM D 520 Type I, modified to allow 0.1 percent retained on the No. 100 sieve. The vehicle component shall consist primarily of a partially hydrolyzed ethyl silicate in an appropriate solvent. The mixed paint shall have the following properties:
 - a. Zinc portion shall be at least 72 percent by weight of the total solids of the dried coating.
 - b. Total solids shall be at least 78 percent by weight.
 - c. The color shall be a distinct contrast with the blast cleaned metal and the finish coat.
 2. **Corrosion Resistance:** Test panels meeting ASTM D 609, having minimum dimensions of 2 inches × 5 inches × 1/8 inch, shall be prepared by cleaning all surfaces per SSPC SP-10 with a one 3 mil profile. A 3 mil Dry Film Thickness (DFT) coating shall be applied and cured according to the manufacturer's recommendations. Individual test panels must pass the following tests:
 - a. **Fresh Water Resistance.** Panels shall be scribed down to base metal with an "X" having at least 2-inch legs and immersed in tap water at 75±5°F. The panels shall show no rusting, blistering, or softening after 30 days. Solution shall be replenished after 7 and 14 days.
 - b. **Salt Water Resistance.** Resistance shall be the same as 630.02 A.2.a except panels shall be immersed in 5 percent sodium chloride solution.
 - c. **Salt Fog Resistance.** Panels shall be scribed down to base metal with an "X" having at least 2-inch legs. Panels shall then be tested according to ASTM B 117. After 1,000 hours the panels shall show no loss of adhesion, rusting, blistering or softening.

B. High-Build Aliphatic Polyurethane Finish Coat. The high-build aliphatic polyurethane finish coat shall be a two-component, weather resistant semigloss finish topcoat, compatible with previously applied coat, and shall have the following properties:

1. Solids by weight shall be minimum of 62 percent. Solids by volume shall be a minimum of 54 percent.
2. The coating shall not run or sag when applied at 10 mils Wet Film Thickness (WFT), unthinned. The coating must be sprayable to a uniform semigloss finish when thinned to the maximum level specified by the manufacturer.
3. The coating color shall be as specified.

C. Aluminum Filled Epoxy Mastic Primer. The aluminum filled epoxy mastic shall be a two-component epoxy. The epoxy mastic must adhere to rusty steel and deteriorated coating systems. The epoxy mastic shall contain a rust inhibiting system which controls undercutting of the paint film.

1. **Composition.** The primary pigment shall be aluminum. Lead containing pigments shall not be present. The vehicle shall be of the epoxy-type and shall not contain coal tar. The curing agent shall allow trouble free application during normal humidity conditions (20 percent to 60 percent relative humidity).

The epoxy mastic shall contain at least 70 percent solids by volume meeting ASTM D 1644. (Modified to a dry time of 72 hours at 100°F., rather than three hours at 105°C.)

2. **Flexibility.** A five mil (DFT) coating of the epoxy mastic shall be applied on a 1/8-inch × 30-inch × 4-inch steel panel sandblasted according to SSPC SP-5. The coating shall be cured for two weeks at 75°F. The coating shall not crack or lose adhesion after the panel is uniformly bent around an 8-inch diameter mandrel.
3. **Resistance.** The epoxy mastic shall meet or exceed the resistance tests when applied in the following manner: Steel panels, 2 inches × 5 inches × 1/8 inch, meeting ASTM D 609, shall be sandblasted according to SSPC SP-5. The panels shall be exposed to the weather for 30 days so uniform rusting occurs. Exposed to weather means stored outdoors at least 30 feet from walls, building or other obstruction to air or moisture movement. The panels shall be hand cleaned with a wire brush according to SSPC SP-2. The epoxy mastic shall be spray applied to the panels at 6 mils DFT in one coat. The coating shall be cured as recommended by the manufacturer.
 - a. **Fresh Water Resistance.** Panels shall be scribed down to base metal with an "X" having at least 2-inch legs and immersed in tap water at 75 ± 5°F. After 30 days the panel shall be unaffected except for discoloration. There shall be no blistering, softening, or visible rusting of the coating beyond 1/16 inch from the center of the scribe.
 - b. **Salt Water Resistance.** Resistance shall be the same as 630.02 C.3.a except panels shall be immersed in 5 percent sodium chloride solution. The solution shall be replenished with fresh solution after 7 and 14 days.

- c. **Salt Fog Resistance.** Panels shall be scribed down to base metal with an "X" having at least 2-inch legs. Panels shall then be tested according to ASTM B 117. After 1,000 hours, the coating shall show no loss of bond, rusting, or blistering beyond 1/16 inch from the center of the scribed mark.
- d. **Weathering Resistance.** Panels shall be tested according to ASTM G 23, Type D. Testing shall begin on the wet cycle. After 1,000 hours, the coating shall show no rusting, loss of adhesion, or blistering.

D. Certification and Final Acceptance. Before use of any paint system, the Department shall be furnished a certified test report from an independent testing laboratory. This certified test report shall show that the specific test results meet all quantitative requirements and resistance test requirements of these Specifications. The certified test report shall contain the exact ratio, by weight, of the pigment component to the vehicle component of the paint used for the tests, the lot tested, the manufacturer's name, brand name of paint, and date of manufacture. New certified test results shall be submitted any time the manufacturing process or the paint formulation is changed. New certified test results may be required when random sampling and testing of material offered for use indicates nonconformance to any of the requirements specified.

To obtain final acceptance of the paint system, a certification shall be furnished stating that the material used was the same as the material tested for manufacturer and brand name approval. The Department may sample and test any or all materials supplied.

E. Packaging and Labeling.

Two-component paint shall be packaged in two-component containers or in two separate containers. The components shall be packaged and proportioned so that when the pigment is mixed with the vehicle, it yields 5 gallons of mixed paint.

Each container shall bear a label which clearly shows the name of the manufacturer, the brand name, and the lot number of the paint. The label on the vehicle container shall include complete instructions for use of this paint, shelf life of the components, and pot life of the mixture. The container shall be coated to prevent attack by the paint components.

630.03 CONSTRUCTION REQUIREMENTS.

A. General.

The coatings shall be applied by the manufacturer's recommendations. A written copy of these recommendations shall be furnished to the Department. The recommendations shall include the mixing and thinning directions; the recommended spray nozzles and pressures; the minimum drying time; and the procedures for coating bolts, nuts, and washers.

Coatings shall be applied in a uniform, even coat and shall be worked into all corners and crevices. Coatings shall be applied with equipment meeting the manufac-

turer's application recommendations. On surfaces inaccessible to spray, the coatings may be applied with sheepskin daubers.

Surfaces with unsatisfactory coatings shall be reblasted, cleaned, and recoated at the Contractor's expense.

During fabrication, coating application, erection, and field repairs, scaffolding or lift platforms shall be provided to permit inspection of the steel.

B. Shop Painting Structural Steel.

1. Surface Preparation.

Surfaces to be coated shall be free of oil or grease prior to blast cleaning. Surfaces coated with oil or grease shall be solvent cleaned according to SSPC SP-1.

Surfaces to be coated shall be blast cleaned to a near white finish according to SSPC SP-10. Abrasives used for blast cleaning shall be either clean dry sand, steel shot, mineral grit, or manufactured grit and shall have a gradation that provides a uniform steel surface profile of 1 to 2.5 mils.

Fins, tears, slivers, weld splatter, and burred or sharp edges shall be removed by grinding and the area shall be reblasted to provide the profile specified before painting.

Blast residue shall be removed from steel surfaces with a commercial grade vacuum cleaner equipped with a brush-type cleaning tool, or by double blowing. Steel shall be kept dust free, dry, and primed within 24 hours after cleaning prior to rust onset.

2. Mixing and Thinning Paint.

All coatings shall be thoroughly mixed so the pigment is completely in suspension and the consistency is uniform. The zinc primer shall be strained over a sieve having openings no larger than a No. 50 sieve and then continuously agitated until application is completed.

Thinning for proper application shall be accomplished by the manufacturer's recommendations.

3. Coating Application.

- a. **Prime Coat.** All structural steel surfaces, including the shear connectors and the upper surface of the top flange shall be primed in the shop. The shop-applied prime coat shall be an inorganic zinc prime coat. Application shall meet SSPC PA-1 and shall be sprayed.

After cleaning the surfaces, the prime coat shall be applied. The DFT of the prime coat shall be in accordance with the manufacturer's written recommendations when measured according to SSPC PA-2.

Areas of deficient primer thickness shall be thoroughly cleaned with power washing equipment to remove all dirt. These deficient areas shall be wire brushed, vacuumed, and recoated.

Where excess coating thickness produces “mud cracking,” the coating shall be repaired according to the manufacturer’s instructions.

All primed surfaces shall be inspected for cleanliness and for the presence of loose zinc and zinc oxidation products (white oxides). When needed, the surface shall be cleaned by wiping, brushing, or flushing with fresh water.

- b. **Finish Coat.** The shop-applied finish coat shall be a high-build aliphatic polyurethane finish coat. Application shall meet SSPC PA-1 and shall be sprayed. The DFT of the finish coat shall be in accordance with the manufacturer’s written recommendations when measured according to SSPC PA-2.

The finish coat shall not be applied until the prime coat is approved. The minimum curing time between coats shall be as recommended by the manufacturer.

Splice plates and filler plates shall not be finish coated in the shop. Contact or faying surfaces of bolted field splices of the main members, shear connectors, and the upper surface of the top flanges shall be masked during the finish coat application.

To prevent top coat bubbling, a mist coat shall be required. The mist coat shall consist of a fast pass of the spray gun to seal the surface of the primer followed immediately by a full wet coat.

Where excessive coating thickness produces “mud cracking,” the coating shall be scraped back to soundly bonded coating and the area shall be recoated.

C. **Handling, Shipping, and Erecting.**

Steel material shall not be loaded for shipment until the shop coating has been approved. The steel shall not be damaged in the shop, during shipment, during erection, and during subsequent construction of the bridge. Overhang brackets shall be padded where they bear on the web. Deck formwork shall be mortar tight to prevent leakage onto the girders. The coating shall be protected from all chains, slings, hooks, and other apparatus used to lift or turn the coated steel. During shipment, girders, diaphragms and other steel parts shall be padded and packed to prevent damage. The steel shall be stored off the ground on padded supports so they cannot fall on or touch one another. The steel shall not be shipped until the necessary equipment is available for handling and storing the steel. The proposed methods for handling and storing the steel shall be submitted at the preconstruction meeting.

Contact or faying surfaces of bolted field splices of main members including splice plates and filler plates, shall be covered until final assembly. Contamination from oil, grease, paint, etc., of these primed surfaces shall be removed by sandblasting to bare metal and recoated with shop primer. No other coating will be allowed on these surfaces. The intention is to provide clean, inorganically coated faying surfaces for field splices.

D. Field Painting.

1. General.

- a. **Weather Conditions.** Paint shall only be applied when the air temperature is at or above 50°F. and below 100°F. Paint shall not be applied when the air is misty, dusty, or otherwise unsatisfactory for work. The surface temperature of the steel shall be 5 degrees above the dew point (exhibits no moisture condensation) before painting is permitted.
- b. **Application.** Field painting shall not be accomplished until the formwork is removed.

Field painting shall be performed with an aluminum-filled epoxy-mastic primer and a finish coat of high-build aliphatic polyurethane. The DFT of the primer and the finish coat shall be in accordance with the manufacturer's written recommendations.

Paint shall be applied during daylight hours by brushing or spraying. After application, the paint film shall be smooth and uniform without skips or areas of excessive paint. When spraying results in unsatisfactory surfaces, paint shall be applied by brushing. The previously-applied coat of paint shall be cured before the next coat is applied.

Only airless spray painting equipment shall be used. Paint shall be continually agitated during the spraying operation and applied in a fine, even spray. The operator shall manipulate the spray so the paint has a uniform thickness when dry. If necessary, the paint shall be immediately brushed out to secure uniform coverage and eliminate runs, wrinkling, blistering, and air holes. If adequate coverage cannot be obtained at rivets, bolt heads, nuts, corners, and edges, paint shall be applied to these areas by hand brushing before spraying.

- c. **Protection.** All parts of the structure and adjacent property shall be protected from spatters of paint or paint materials. Canvas shields or other means may be required to protect traffic. Freshly painted surfaces shall be protected to prevent dust and dirt from contacting these surfaces.

Protective shields shall be provided so paint drift does not damage adjacent parts of the structure and adjacent property. Spray painting shall be suspended whenever the application or drift is not being properly controlled.

- d. **Responsibility for Paint Damage Claims.** The Contractor shall have a representative available at the job site to receive and promptly process paint damage claims. The Contractor, or representative, shall record the name and address of the claimant, date, and nature of damage; amount of monetary damages sought, date paid; and promptly report all claims to the Engineer.

2. Field Painting New Structural Steel.

After assembly, exposed surfaces of nuts, bolts, and washers shall be cleaned with a mineral spirit solvent followed by a hot water rinse. After these sur-

faces are thoroughly dry, they shall be given a coat of aluminum-filled epoxy-mastic prime coat, and coated with polyurethane finish coat.

Damaged finish coated areas shall be repaired by cleaning and applying the epoxy mastic primer before applying the finish coat.

Surfaces coated with inorganic zinc silicate primer shall be inspected for damage and cleanliness before finish coating. Damaged areas shall be repaired by priming with epoxy mastic. Necessary cleaning shall be done with hot water or steam. The finish coat shall not be applied until all cleaning and repairing has been inspected and accepted.

3. **Rehabilitation Painting.**

Surfaces to be coated shall be prepared by blast cleaning. The level of preparation shall meet SSPC SP-6, "Commercial Blast Cleaning." Existing paint remaining along the edges of blast-cleaned areas shall be feathered and cleaned to assure a bond of new to old paint.

630.04 METHOD OF MEASUREMENT.

Measurement for painting shall be a Lump Sum item for furnishing and delivering all paint materials, preparing the surfaces and applying the primer and finish coat of paint.

If there is no bid item for Sandblasting and Painting, this work shall be included in the bid item for "Structural Steel."

630.05 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price as follows:

Pay Item	Pay Unit
Sandblasting and Painting	Lump Sum

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

SECTION 638 STRUCTURAL PLATE CULVERTS

638.01 DESCRIPTION.

This item consists of furnishing, assembling, and backfilling structural plate pipe, elliptical structural plate pipe, pipe arches, or arches.

638.02 MATERIALS.

Material shall meet Section 830.02.

638.03 CONSTRUCTION REQUIREMENTS.

- A. **Excavation.** Excavation shall meet Section 714.03 A.1 and as modified here.
When a pipe structure is erected in a trench, the width of the trench shall be sufficient to permit thorough tamping of the earth backfill.
- B. **Bedding.** Bedding shall meet Section 714.03 A.2.
- C. **Assembly and Installation.** Pipe shall be assembled by the manufacturer's assembly instructions. Care shall be exercised in the use of drift pins or pry bars to prevent chipping or injury to the galvanized coating.
- D. **Backfill.** After assembling the pipe, the backfill shall be placed uniformly and equally on each side of the pipe in layers not to exceed 12 inches before compaction. Adequate earth cover shall be placed over the structure before heavy construction equipment is driven over it. Compaction of each layer of the backfill shall be equal to the compaction as described in Sections 714.03 A.6 and 714.03 A.7.

638.04 METHOD OF MEASUREMENT.

- A. **Linear Basis.** When the linear unit quantity is shown on the bid schedule, the structural plate pipe, elliptical structural plate pipe, arches, or pipe arches will be measured in Linear Feet, installed in place, completed, and accepted. The number of Linear Feet will be measured as shown on the Plans for the particular item.
- B. **Lump Sum Basis.** Each structural plate culvert shall be the type, size, gauge, and length designated and, for the purpose of measurement and payment, shall be considered as a unit installed in place, completed, and accepted.

638.05 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price as follows:

Pay Item	Pay Unit
Structural Plate Pipe	Linear Foot, Lump Sum
Elliptical Structural Plate Pipe	Linear Foot, Lump Sum
Pipe Arch	Linear Foot, Lump Sum
Arch	Linear Foot, Lump Sum

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

**SECTION 650
REPAIR AND OVERLAY OF
PORTLAND CEMENT CONCRETE
BRIDGE DECKS WITH LOW-SLUMP CONCRETE**

650.01 DESCRIPTION.

This work consists of removing unsound concrete or chloride contaminated sound concrete with mechanical or hydrodemolition equipment and replacing and resurfacing the bridge deck with low-slump concrete.

650.02 MATERIALS.**A. General.**

Item	Section
Class AAE-3 Concrete	802
Portland Cement	804.01
Concrete Admixtures	808
Burlap	810
Water	812
Fine Aggregate	816.01
Coarse Aggregate*	816.02

*Coarse aggregate for Portland Cement Concrete shall be crushed stone with at least 75 percent by weight of the particles retained on the No. 4 sieve having at least one fractured face. Aggregate shall meet Size No. 5.

B. Special Requirements for Low-Slump Concrete.

- Cement.** Type I or IA cement shall be used.
- Basic absolute volume per Unit Volume of Concrete:

Coarse Aggregate (Size 5)	0.3121
Fine Aggregate	0.3121
Air	0.0600
Water	0.1603
Cement (Type I or IA)	0.1555
	1.0000

- Approximate quantities of dry materials per cubic yard of concrete:

Coarse Aggregate (Size 5)	1,393 lbs.
Fine Aggregate	1,393 lbs.
Cement (8.75 bags)	823 lbs.

These quantities are based on the following assumptions:

Specific gravity of cement	3.14
Specific gravity of aggregate	2.65
Weight of one cubic foot of water	62.4 lbs.

- An approved water-reducing admixture shall be used.
- The slump measured using AASHTO T 119 shall not exceed 1 inch.
- The concrete shall have an entrained air content of 6 percent with a tolerance of plus or minus 1 percent. The method of entraining air shall meet Section 802.01 D.
- Grout for bonding the overlay to the existing concrete shall consist of equal parts, by weight, of Portland Cement and fine aggregate mixed with sufficient water to form a stiff slurry. The slurry shall have a consistency that permits application with a stiff brush or broom to a thin even coating that does

not run or puddle in low spots. For sealing construction joints, the grout shall be thinned as necessary.

650.03 EQUIPMENT.

- A. **Surfacing Preparation Equipment.** Surface preparation equipment shall be of the following types:
1. **Mechanical Equipment.**
 - a. Scarifying equipment shall meet Section 152.05 or 153.15.
 - b. Sawing equipment shall meet Section 153.12.
 - c. Sandblasting equipment shall remove rust scale from reinforcing bars and small chips of concrete partially loosened by milling. Air lines used for sandblasting or high pressure air blast shall be equipped with filters to remove all oil from the air.
 - d. Power driven hand tools, such as pneumatic hammers, shall not be heavier than the nominal 30-pound class and shall be operated at an angle of 45 degrees or less measured from the slab. Chipping hammers heavier than a nominal 15-pound class shall not be used to remove concrete around or beneath reinforcing bars. Pointed bits for power hammers shall not be used except for full depth removal.
 - e. Hand tools such as hammers and chisels shall be used for removal of final particles of unsound concrete or to achieve the required depth.
 2. Hydrodemolition equipment shall meet Section 153.16.
- B. **Proportioning and Mixing Equipment.** Proportioning and mixing equipment shall be of a self-contained mobile type (not conventional ready-mix truck), meeting Section 153.02 C.
- C. **Placing and Finishing Equipment.**
1. Placing and finishing equipment shall include hand tools for placing and brushing-in freshly mixed mortar, and for distributing material to the depth that can be struck off with the screed. Hand operated vibrators and screeds shall be used to place and finish small areas of work.
 2. A drag and a metal tining device meeting Section 602.03 B.2 shall be used for the final finish.

650.04 REMOVAL AND OVERLAY WITH THE USE OF MECHANICAL EQUIPMENT.

- A. **Classification of Overlays.**
1. **Class 1 Overlay.** Class 1 overlay consists of removing deck concrete to a depth of 1/2 inch below the existing finished surface, except at drains and elsewhere as specified; disposing of the removed concrete; and overlaying

with concrete to the depth specified. Thickness of the concrete overlay shall be measured from a level 1/2 inch below the original surface to the final raised surface as specified.

2. **Class 2 Overlay.** Class 2 overlay areas will be determined by the Engineer after Class 1 overlay has been accomplished. Class 2 overlay consists of removal, disposal, and replacement of concrete below the bottom of the Class 1 overlay. The lower limit of the Class 2 overlay shall be the top of the bars in the top layer of reinforcing steel. Concrete removed below the top of the top bar coincidental with Class 2 overlay is part of the Class 2 overlay area. The excavated volume shall be replaced with concrete to a level bounding the Class 1 overlay.
3. **Class 2-A Overlay.** Class 2-A overlay areas will be determined by the Engineer after Class 1 and Class 2 overlay have been accomplished. Class 2-A overlay consists of removal, disposal, and replacement of concrete around the periphery of reinforcing bars in the top mat. Class 2-A overlay will be ordered when an isolated bar has lost bond on more than 1/2 of its circumference. The excavated volume shall be replaced with concrete bounding the Class 2 overlay.

Class 3 overlay may be ordered in lieu of Class 2-A overlay if damage to sound concrete between bars is suspected.

4. **Class 3 Overlay.** Class 3 overlay areas will be determined by the Engineer after Class 1 and Class 2 overlay have been accomplished. Class 3 overlay consists of removal, disposal, and replacement of concrete below the bottom of the Class 2 overlay to sound concrete or to a maximum depth bound by the top of the top bar of the bottom mat of reinforcing steel. The excavated volume shall be replaced with concrete to a level bounding the Class 2 overlay.
5. **Class 4 Overlay.** Class 4 overlay will be determined by the Engineer after Class 1, Class 2, and Class 3 overlay have been accomplished. Class 4 overlay consists of removal and disposal of concrete below the level described for Class 3 overlay and for the full remaining depth of the deck and replacement of the excavated volume with AAE-3 Portland Cement Concrete or low-slump concrete to a level bounding the Class 1 overlay.

Edges of the full depth hole in the deck shall be nearly vertical or tapered inward from top to bottom. A reverse taper will not be permitted. The underside of the completed deck replacement shall have a neat, smooth appearance.

B. Construction Requirements.

1. General.

All concrete aggregate shall be available for sampling and testing, for a minimum of five days before lane closure. The Department is not responsible for delays or additional costs caused by failing aggregate.

Asphalt overlays shall be removed before any concrete removal. Asphalt removal equipment shall not damage the surface of the concrete deck.

To ensure proper overlay thickness, measurements shall be made from the finisher screed to the prepared deck surface.

The deck surface shall be sandblasted and cleaned with compressed air after grinding and concrete removal operations are completed. Wet sandblasting shall not be used.

All reinforcing steel shall be thoroughly sandblast cleaned of all deleterious material and concrete. Reinforcing bars which have lost 1/4 or more of their original dimensions shall be removed and replaced with a new lap-spliced bar. Reinforcing bars damaged due to removal operations shall be replaced at the Contractor's expense.

2. **Removal Requirements.**

- a. **Class 1 Overlay.** The existing concrete deck area shall be uniformly ground to a depth of 1/2 inch. Removal to a greater depth shall be required at drains and other noted locations.
- b. **Class 2 Overlay.** Concrete shall be removed by chipping or by a combination of grinding and chipping. Removal shall be considered to start 1/2 inch below the existing surface.
- c. **Class 2-A Overlay.** Concrete shall be removed from around the periphery of the reinforcing steel using power hammers and hand tools without cutting, stretching, or damaging any exposed reinforcing steel. A minimum clearance of 3/4 inch around the bar shall be attained.
- d. **Class 3 Overlay.** Concrete shall be removed by chipping with power hammers and hand tools without cutting, stretching, or damaging any exposed reinforcing steel.
- e. **Class 4 Overlay.** This work consists of complete removal of that portion of the bridge deck which the Engineer designated for full depth removal. Forms shall be provided to enable placement of new concrete.

3. **Mixing of Materials.**

- a. **Class AAE-3 Concrete.** Concrete shall be mixed according to Section 802.
- b. **Low-Slump Concrete.** Concrete shall be mixed at the site. The mixing rate shall allow finishing operations to proceed at a steady rate.

4. **Placing, Finishing, and Curing Overlay.**

a. **General.**

At longitudinal construction joints, the surface course previously placed shall be sawn to a straight and vertical edge before the adjacent course is placed.

After the machine finishing has been completed, hand finishing with a wood float may be required to produce a tight, uniform surface.

Immediately after finishing, all vertical joints with adjacent concrete shall be sealed by painting with a thinned grout before the curing operation begins.

A drag shall be pulled over the surface in a longitudinal direction while the concrete is plastic. It shall be immediately followed with a transverse metal tine finish. The tining shall be stopped 18 inches from the face of the curb. The tining device shall be drawn transversely across the full width of the pavement without overlapping passes. The tining shall be neat and uniform, and shall produce grooves without tearing the surface or bringing course aggregate to the surface. The finished surface shall be free from rough or porous areas and irregularities resulting from improper handling of the device. Concrete surfaces which do not meet the above requirements shall be corrected at the Contractor's expense by cutting transverse grooves in the hardened concrete with diamond-bladed equipment.

The surface tolerance of the finished concrete overlay shall be less than or equal to 3/16 inch in 10 feet. Measurements for smoothness will be taken on approximately 2-foot spacing over the entire deck. Any portion of the deck not meeting the tolerance shall be corrected by grinding or reoverlying the deck. The tined surface texture shall be restored with diamond bit cutting equipment. Grinding or grooving that decreases the cover to less than 1-1/2 inches over the top of the reinforcing steel shall not be used.

b. Special Requirements for Low-Slump Concrete.

Concrete for Class 1, 2, 2-A, and 3 overlay areas may be placed in one operation.

Where full depth concrete is required, Class AAE-3 or low-slump concrete may be used. Concrete for the Class 4 overlay areas shall be struck off at the bottom level of Class 1 unless the Class 4 falls entirely with a Class 2 or 3 overlay area. In that case, the concrete shall match the prepared surface of either the Class 2 or 3 overlay area. The concrete shall receive the wet cure meeting Section 602.03 F.3 for at least 72 hours, and shall be sandblasted and cleaned before overlaying.

The prepared deck surface shall be dry to permit absorption of the bonding grout. All vertical and horizontal surfaces shall receive a thorough, even coating of bonding grout at a controlled rate so that grout does not dry before covering with new concrete.

The concrete shall be screeded to final grade and consolidated to 98 percent of the unit weight using AASHTO T 121.

The surface shall receive a wet cure meeting Section 602.03 F.3 except that the curing period shall be five days. Concrete that is not wet cured within 30 minutes after placement shall be removed to the original prepared surface and replaced at the Contractor's expense.

5. Limitations of Operations.

No preparation work will be allowed until the lane or strip is closed for traffic. This lane shall remain closed until the overlay has been completed.

No loads other than equipment needed to remove and replace concrete shall be allowed on the deck that has undergone preparation before placement and curing of concrete. Mixers shall not be operated on the structure. Equipment used for transporting concrete shall not damage the prepared deck surface and shall be designed for transporting concrete. Equipment shall not leak oil, hydraulic fluid, or any other contaminant onto the prepared deck surface. Equipment used to transport mortar or concrete shall be of sufficient size and adequate design to handle the volume of material without spilling or dripping.

No vehicular traffic shall be permitted on the new overlay until the specified curing period is completed. If daily mean temperatures fall below 55°F. during the five days following concrete placement, additional curing days will be required.

When temperatures are above 80°F., placement shall be made at night or early morning hours by installing and operating necessary lighting. Rescheduling an overlay placement may be required if weather conditions adversely effect the quality of the overlay.

Overlays shall not be placed unless the temperature is 45°F. and rising.

Bridge deck overlays shall not be placed after September 15 unless authorized by the Engineer.

C. Method of Measurement.

1. **Class 1, 2, 3, and 4 Overlay.** The quantities of Class 1, Class 2, Class 3, and Class 4 Overlay will be measured by the Square Yard. Removal of asphalt overlay will be included in this bid item.
2. **Class 2-A Overlay.** The quantity of Class 2-A Overlay will be measured in Linear Feet.

D. Basis of Payment.

1. Quantities measured will be paid for at the Contract Unit Price for the pay items shown. Payment will be full compensation for all labor, equipment, and materials necessary to complete the work. This includes removal, disposal, and replacement of all concrete for Class 1, 2, 2-A, 3, and 4 overlays.

When there is no item for Class 4 overlay, payment will be made according to Section 104.03. Any Class 1, 2, 2-A, or 3 overlay authorized before Class 4 overlay, shall be paid for at the unit bid prices.

No adjustment in unit bid prices, according to Section 104.03 B, will be made for Class 2, 2-A, 3, or 4 Overlays.

2. If it becomes necessary to increase the average thickness of the Class 1 overlay over that provided on the Plans, the following procedure will be used to determine compensation for the additional concrete required:

Step 1: Before scarification, the existing deck elevations will be determined by longitudinal profiles taken along lines corresponding to the edges and

mid-width of each overlay pour. The elevations along each profile will be measured to the nearest 0.01 foot at intervals not exceeding 10 feet.

Step 2: The Engineer will establish and record the final grades for the surface of the Class 1 overlay. The difference between Plan grade and actual grade will be compared to determine the average increase in thickness of the overlay. This increase will be used to determine the volume of additional concrete.

Step 3: For the additional concrete, measured as provided in Step 2, payment will be made at the rate specified in the Price Schedule (PS-1) in the Proposal Form.

650.05 REMOVAL AND OVERLAY WITH THE USE OF HYDRODEMOLITION EQUIPMENT.

A. Classification of Removal.

1. **Class 1-H Removal.** Class 1-H removal will consist of that concrete removed by hydrodemolition equipment in the first pass after it is calibrated to remove 1/2 inch of sound concrete in a trial area as defined below. Concrete removed below the 1/2-inch depth coincidental with Class 1-H removal is considered a part of Class 1-H removal.
2. **Class 2-H Removal.** Class 2-H removal areas will be determined by the Engineer after Class 1-H removal has been accomplished. Class 2-H removal areas will consist of a second pass with the hydrodemolition equipment to remove and dispose the concrete below the bottom of the Class 1-H removal to sound concrete or to a maximum depth bound by the top of the top bar of the bottom mat of reinforcing steel. Concrete removed below the top of the top bar of the bottom mat of reinforcing steel coincidental with Class 1-H or 2-H removal is considered a part of Class 1-H or 2-H removal.
3. **Class 3-H Removal.** Class 3-H removal areas will be determined by the Engineer after Class 2-H removal has been accomplished. Class 3-H removal consists of a third pass with the hydrodemolition equipment to remove and dispose of concrete below the level described for Class 2-H removal and for the full remaining depth of the deck.

B. Construction Requirements.

1. General.

All concrete aggregate shall be available for sampling and testing for a minimum of five days before lane closure. The Department is not responsible for delays or additional cost caused by failing aggregate.

Asphalt overlays shall be removed before any concrete removal. Asphalt removal equipment shall not damage the surface of the concrete deck.

To ensure proper overlay thickness, measurements shall be made from the finisher screed to the prepared deck surface.

For Class 1-H removal, a trial area of approximately 30 square feet representing sound concrete will be designated by the Engineer to set the hydrodemolition equipment to remove 1/2 inch of sound concrete.

A second trial area of approximately 30 square feet of deteriorated concrete will be designated by the Engineer to test whether the setting of the hydrodemolition equipment will completely remove the unsound concrete.

If unsound concrete is not completely removed, the procedure shall be repeated on sound and deteriorated areas and the equipment shall be readjusted until unsound concrete is removed completely.

Sound concrete is defined as concrete free of chemical defects, delamination, spalling, cracks, etc.

Concrete in areas of limited accessibility shall be removed with hand-held hydrodemolition equipment or mechanical equipment. Any work to remove concrete in areas of limited accessibility or in occasional high spots shall be included in the Class 1-H removal. This includes the area adjacent to the existing curbs.

2. Removal Requirements.

- a. **Class 1-H Removal.** The existing concrete deck area shall be removed by hydrodemolition to a minimum depth of 1/2 inch.
- b. **Class 2-H Removal.** After the Class 1-H removal, the area shall be cleaned. The surface shall be dry and the Engineer will sound the deck and mark any additional loose, unsound, deteriorated concrete. The machine shall be set for the complete removal of unsound concrete in the areas designated by the Engineer. Hydrodemolition of these areas is considered Class 2-H removal.
- c. **Class 3-H Removal.** This work consists of full depth removal of a portion of the bridge deck. Forms shall be provided to enable placement of new concrete.
- d. Removal of concrete debris shall be accomplished by hand or mechanical means, and shall be accomplished directly following the hydrodemolition process to prevent the debris from settling or adhering to the surface of remaining sound concrete. All debris which is allowed to adhere to the surface of sound concrete shall be removed with pressurized water. Care shall be exercised to avoid any damage to the remaining sound concrete. Debris shall be disposed of as provided in Section 202.02.

3. Mixing of Materials.

- a. **Class AAE-3 Concrete.** Concrete shall be mixed according to Section 802.
- b. **Low-Slump Concrete.** Concrete shall be mixed at the site. The mixing rate shall allow finishing operations to proceed at a steady rate.

4. **Placing, Finishing, and Curing Overlay.**

a. **General.**

At longitudinal construction joints, the surface course previously placed shall be sawn to a straight and vertical edge before the adjacent course is placed.

After the machine finishing has been completed, hand finishing with a wood float may be required to produce a tight, uniform surface.

Immediately after finishing, all vertical joints with adjacent concrete shall be sealed by painting with a thinned grout before the curing operation begins.

A drag shall be pulled over the surface in a longitudinal direction while the concrete is plastic. It shall be immediately followed with a transverse metal tine finish as specified in Section 602.03 B.2.a.

b. **Special Requirements for Low-Slump Concrete.**

Concrete for Class 1-H or 2-H removal areas may be placed in one operation.

Where full depth concrete is required, Class AAE-3 or low-slump concrete may be used. Concrete for the Class 3-H removal areas shall be struck off at the bottom level of Class 1-H unless the Class 3-H falls entirely within a Class 2-H removal area. In that case, the concrete shall match the prepared surface of the Class 2-H area. The concrete shall receive the wet cure specified in Section 602.03 F.3 for at least 72 hours, and shall be sandblasted and cleaned before overlaying.

The prepared deck surface shall be dry to permit absorption of the bonding grout. All vertical and horizontal surfaces shall receive a thorough, even coating of bonding grout at a controlled rate so the grout does not dry before covering with new concrete.

The concrete shall be screeded to a final grade and consolidated to 98 percent of the unit weight using AASHTO T 121.

The surface shall receive a wet cure meeting Section 602.03 F.3 except that the curing period shall be five days. Concrete that is not wet cured within 30 minutes after placement shall be removed to the original prepared surface and replaced at the Contractor's expense.

5. **Limitations of Operations.**

No preparation work will be allowed until the lane or strip is closed for traffic. This lane shall remain closed until the overlay has been completed.

No loads other than equipment needed to remove and replace concrete shall be permitted on the deck that has undergone preparation before placement and curing of concrete. Mixers shall not be operated on the structure. Equip-

ment used for transporting concrete shall not damage the prepared deck surface and shall be designed for transporting concrete. Equipment shall not leak oil, hydraulic fluid, or any other contaminant onto the prepared deck surface. Equipment used to transport mortar or concrete shall be of sufficient size and adequate design to handle the volume of material without spilling or dripping.

Vehicular traffic shall not be permitted on the new overlay until the specified curing period is completed. If daily mean temperatures fall below 55°F. during the five days following concrete placement, additional curing days will be required.

When temperatures are above 80°F., placement shall be made at night or early morning hours by installing and operating necessary lighting. Rescheduling an overlay placement may be required if weather conditions have an adverse effect on the quality of the overlay.

Overlays shall not be placed unless the temperature is 45°F. and rising.

Bridge deck overlays shall not be placed after September 15 unless authorized by the Engineer.

C. METHOD OF MEASUREMENT.

1. **Class 1-H, 2-H, and 3-H Removal.** The quantities of Class 1-H, Class 2-H, and Class 3-H Removal will be measured by the Square Yard. Removal of asphalt overlay shall be included in this item.
2. **Overlay Concrete.** Overlay concrete will be measured by the Cubic Yard and will be based on the actual quantity used.

D. BASIS OF PAYMENT.

1. Quantities measured will be paid for at the Contract Unit Price for the pay items shown. Payment will be full compensation for all labor, equipment, and materials necessary to complete the work. When there is no item for Class 3-H Removal, payment will be made according to Section 104.03. Any Class 1-H or 2-H removal authorized before Class 3-H removal, shall be paid for at the unit bid prices.
2. **Overlay Concrete.** The quantity shown on the Plans will be paid for at the Contract Unit Price. Any overlay concrete in excess of that shown on the Plans shall be paid for at the rate specified in the Price Schedule (PS-1) in the Proposal Form. The provisions of Section 104.03 B will not be used to justify a change in Unit Price for the extra concrete.

SECTION 700
MISCELLANEOUS CONSTRUCTION

**SECTION 702
MOBILIZATION**

702.01 DESCRIPTION

702.02 PAYMENTS

**SECTION 704
TRAFFIC CONTROL**

704.01 DESCRIPTION

704.02 MATERIALS AND EQUIPMENT

- A. Sign Backing Materials
- B. Reflective Sheeting
- C. Flexible Roll-Up Sign
- D. Flat Sheet Sign Faces
- E. Barricades
 - 1. Wood Rails
 - 2. Aluminum Rails
- F. Delineator Drums
- G. Traffic Cones
- H. Tubular Markers
- I. Vertical Panels
- J. Delineators
- K. Portable Barriers
- L. Warning Lights
- M. Advanced Warning Flashing or Sequencing Arrow Panels
- N. High-Level Warning Device
- O. Flagging
- P. Pilot Car
- Q. Portable Signs

704.03 CONSTRUCTION REQUIREMENTS

- A. General
- B. Project Terminal Signing
- C. Work Area Signing
- D. Existing Signs
- E. Route Markers
- F. Detour Signing
- G. Highways Closed to Traffic
- H. Restricted Speed Zones
- I. Temporary Suspension
- J. Barricade Application
- K. Drum Application
- L. Traffic Cone and Tubular Marker Application
- M. Flexible Delineator Application
- N. Vertical Panel Application
- O. Delineator Application
- P. Portable Barrier Application
- Q. Lighting Device Application
 - 1. Type III or IV Reflective Sheeting
 - 2. Flashing Lights (Type A, Low-Intensity)

- 3. Flashing Lights (Type B, Hi-Intensity)
- 4. Steady-Burn Lights (Type C)
- 5. Mounting Height of Warning Lights
 - a. Barricade and Portable Standards
 - b. Signs
 - c. Vertical Channelizing Devices and Independent Supports
- 6. Advance Warning Arrow Panels
- 7. Floodlights
- R. High-Level Warning Device
- S. Obliteration of Pavement Marking
- T. Construction Zone Marking
- U. Traffic Control Personnel
 - 1. Traffic Control Supervisor
 - a. Qualifications
 - b. Duties
 - c. Traffic Control Course
 - 2. Watchpersons
- V. Emergency Control
- W. Maintenance of Traffic Control Devices
- X. Flagging
- Y. Pilot Car
- Z. Flag Application

704.04 METHOD OF MEASUREMENT

704.05 BASIS OF PAYMENT

SECTION 706 FIELD LABORATORY

706.01 DESCRIPTION

706.02 REQUIREMENTS

- A. Type A, Field Laboratory
- B. Type B, Field Laboratory
- C. Type C, Field Laboratory

706.03 METHOD OF MEASUREMENT

706.04 BASIS OF PAYMENT

SECTION 708 EROSION CONTROL

708.01 DESCRIPTION

708.02 SEEDING, SODDING, AND MULCHING

- A. Description
- B. Materials
 - 1. Seeding
 - a. General
 - b. Seed Testing
 - c. Labeling

- d. Seed Classes
- e. Fertilizer Requirements
- 2. Sodding
 - a. General
 - b. Peat Sod
 - c. Sampling, Testing, and Certification
- 3. Mulching
 - a. Hydro Mulching
 - b. Grass Hay or Straw Mulch
 - c. SS-1 Emulsion
- C. Construction Requirements
 - 1. Seeding
 - a. General
 - b. Topsoil
 - c. Types of Seedbed Preparation
 - d. Seasonal Limitations
 - e. Seeding Equipment Requirements
 - f. Fertilizer
 - g. Reseeding and Repair
 - h. Temporary Care
 - 2. Sodding
 - a. Preparation of the Earth Bed
 - b. Placing the Sod
 - c. Staking the Sod
 - d. Clean-Up
 - e. Fertilizer
 - f. Care and Maintenance
 - g. Acceptance
 - 3. Hydro-Mulch
 - 4. Grass, Hay, or Straw Mulch
 - a. General
 - b. Equipment
 - c. Application
 - d. Anchoring
 - e. Temporary Maintenance
- D. Method of Measurement
- E. Basis of Payment

708.03 EROSION CONTROL BLANKET AND TURF REINFORCEMENT MAT

- A. Description
- B. Materials
- C. Construction Requirements
 - 1. Wood Excelsior or Fiber Mat
 - 2. Erosion Control Fabric
 - 3. Fiberglass Roving
 - 4. Repair of Soil Retention Blanket
- D. Method of Measurement
- E. Basis of Payment

708.04 RIPRAP AND AGGREGATE CUSHION

- A. Description
- B. Materials
 - 1. Wire Mesh
 - 2. Grout

- 3. Riprap
 - a. Gradation
 - b. Field Stone
 - c. Quarry Stone
- 4. Aggregate Cushion
- C. Construction Requirements
 - 1. General
 - 2. Aggregate Cushion
 - 3. Wire Mesh Riprap
 - 4. Loose Rock Riprap
- D. Method of Measurement
- E. Basis of Payment
- 708.05 FABRIC FORMED SLOPE PROTECTION
 - A. Description
 - B. Materials
 - C. Construction Requirements
 - D. Method of Measurement
 - E. Basis of Payment
- 708.06 CONCRETE SLOPE PROTECTION
 - A. Description
 - B. Materials
 - C. Construction Requirements
 - 1. Preparation of Subgrade
 - 2. Placing Reinforcement
 - 3. Composition of Concrete
 - 4. Placing Concrete
 - 5. Relief Joints
 - 6. Finishing Concrete
 - 7. Curing Concrete
 - 8. Tests on Concrete
 - D. Method of Measurement
 - E. Basis of Payment
- 708.08 FIBER ROLLS
 - A. Description
 - B. Materials
 - C. Construction Requirements
 - 1. Installation
 - 2. Maintenance
 - D. Method of Measurement
 - E. Basis of Payment
- 708.09 FLOTATION SILT CURTAIN
 - A. Description
 - B. Materials
 - C. Construction Requirements
 - 1. Installation
 - a. Still Water
 - b. Moving Water
 - c. Work Area
 - 2. Maintenance
 - 3. Removal
 - D. Method of Measurement
 - E. Basis of Payment

708.10 STABILIZED CONSTRUCTION ACCESS

- A. Description
- B. Materials
 - 1. Aggregate
 - 2. Geotextile Fabric
- C. Construction Requirements
- D. Maintenance
- E. Method of Measurement
- F. Basis of Payment

**SECTION 709
GEOTEXTILE FABRICS**

709.01 DESCRIPTION

709.02 MATERIALS

709.03 CONSTRUCTION REQUIREMENTS

- A. General
- B. Geotextile Separation Fabric
- C. Filter Fabric (Underdrains)
- D. Filter Fabric (Riprap)
- E. Geotextile Reinforcement Fabric

709.04 METHOD OF MEASUREMENT

709.05 BASIS OF PAYMENT

**SECTION 710
TEMPORARY BYPASS**

710.01 DESCRIPTION

710.02 CONSTRUCTION REQUIREMENTS

710.03 METHOD OF MEASUREMENT

710.04 BASIS OF PAYMENT

**SECTION 714
CULVERTS, STORM DRAINS, EDGE DRAINS,
AND UNDERDRAINS**

714.01 DESCRIPTION

714.02 MATERIALS

- A. Culverts and Storm Drains
- B. Underdrains
- C. Bridge Approach Drains
- D. Edge Drains

714.03 CONSTRUCTION REQUIREMENTS

- A. Culverts and Storm Drains
 - 1. Excavation
 - 2. Bedding
 - 3. Handling and Assembly
 - 4. Laying Pipe
 - 5. Joining Pipe
 - 6. Relaid Pipe
 - 7. Backfilling for Pipe Installed in Embankments
 - 8. Backfilling for Pipe Installed in Trenches
 - 9. Corrugated Polyethylene Pipe
 - 10. Connection to Manholes, Inlets, and Pipes
- B. Smooth Wall Steel Pipe Culvert
- C. Underdrains
- D. Bridge Approach Drains
- E. Edge Drains
- F. Drainage

714.04 METHOD OF MEASUREMENT

714.05 BASIS OF PAYMENT

SECTION 720 MONUMENTS AND RIGHT OF WAY MARKERS

720.01 DESCRIPTION

720.02 MATERIALS

720.03 CONSTRUCTION REQUIREMENTS

- A. Monuments
- B. Right of Way Markers

720.04 METHOD OF MEASUREMENT

720.05 BASIS OF PAYMENT

SECTION 722 MANHOLES, CATCH BASINS, AND INLETS

722.01 DESCRIPTION

722.02 MATERIALS

722.03 CONSTRUCTION REQUIREMENTS

- A. Excavation
- B. Brick Masonry Construction
- C. Precast Concrete Masonry Units
- D. Precast RCP Manholes, Inlets, and Catch Basins
- E. Concrete Construction (Cast-in-Place)
- F. Concrete Base (Pre-cast or Cast-in-Place)
- G. Pipe Connections
- H. Reinforcement
- I. Placing Castings

- J. Backfill
 - K. Cleaning
 - L. Adjustments to Existing Units
- 722.04 METHOD OF MEASUREMENT
- 722.05 BASIS OF PAYMENT

SECTION 724
WATER MAINS, WATER LINES, AND SEWER LINES

- 724.01 DESCRIPTION
- 724.02 MATERIALS
- A. Pipes
 - B. Joints and Fittings
 - C. Rubber Gaskets
 - D. Gate Valves
 - E. Butterfly Valves
 - F. Valve Boxes
 - G. Hydrants
 - H. Tapping Saddle and Tapping Valve or Tapping Sleeve and Tapping Valve
 - I. Aggregates
 - J. Concrete
 - K. Corporation Stops (Cocks), Curb Stops, and Curb Boxes
- 724.03 CONSTRUCTION REQUIREMENTS
- A. General
 - B. Excavation and Trenching
 - 1. Excavation
 - 2. Bedding
 - 3. Backfilling
 - C. Water Main Requirements
 - 1. Laying Water Mains
 - 2. Testing and Disinfecting Lines
 - 3. Thrust Blocks
 - 4. Hydrants
 - 5. Reset Hydrant
 - 6. Backfill
 - 7. Marking Tape
 - D. Water and Service Lines
 - 1. General
 - 2. Laying Water Line
 - 3. Testing
 - E. Sanitary Sewer Pipe Requirements
- 724.04 METHOD OF MEASUREMENT
- 724.05 BASIS OF PAYMENT

SECTION 740
DAMPPROOFING AND FABRIC WATERPROOFING

- 740.01 DESCRIPTION

- 740.02 MATERIALS
- 740.03 CONSTRUCTION REQUIREMENTS
 - A. General
 - B. Dampproofing
 - C. Fabric Waterproofing
 - D. Black Polyethylene Membrane
- 740.04 METHOD OF MEASUREMENT
- 740.05 BASIS OF PAYMENT

**SECTION 744
INSULATION BOARD (POLYSTYRENE)**

- 744.01 DESCRIPTION
- 744.02 MATERIALS
- 744.03 CONSTRUCTION REQUIREMENTS
 - A. Subgrade Preparation
 - B. Installation
 - C. Cover Material
 - D. Traffic
- 744.04 METHOD OF MEASUREMENT
- 744.05 BASIS OF PAYMENT

**SECTION 748
CURB AND GUTTER**

- 748.01 DESCRIPTION
- 748.02 MATERIALS
- 748.03 CONSTRUCTION REQUIREMENTS
 - A. Cast-in-Place Concrete Curb and Gutter
 - 1. Equipment
 - 2. Excavation
 - 3. Base
 - 4. Mixing, Placing, and Finishing
 - 5. Use of Water
 - 6. Joints and Joint Sealing
 - 7. Curing
 - 8. Backfill
 - 9. Operational Limits
 - B. Precast Concrete Curbing
 - 1. Excavation
 - 2. Base
 - 3. Installation
 - 4. Surface Finish
 - 5. Joints

- 6. Backfill
- C. Bituminous Curbing
 - 1. Excavation
 - 2. Base
 - 3. Preparation of Bed
 - 4. Placing
 - 5. Painting and Sealing
 - 6. Backfill

748.04 METHOD OF MEASUREMENT

748.05 BASIS OF PAYMENT

SECTION 750 SIDEWALKS AND DRIVEWAYS

750.01 DESCRIPTION

750.02 MATERIALS

750.03 CONSTRUCTION REQUIREMENTS

- A. Forms
- B. Excavation
- C. Base
- D. Placing Concrete
- E. Finishing
- F. Use of Water
- G. Joints
- H. Curing
- I. Backfill
- J. Operational Limits
- K. Detectable Warning Panels

750.04 METHOD OF MEASUREMENT

750.05 BASIS OF PAYMENT

SECTION 752 FENCING - INSTALLATION AND RESETTING

752.01 DESCRIPTION

752.02 MATERIALS

752.03 CONSTRUCTION REQUIREMENTS

- A. General
- B. Installing Line Posts
- C. Corner and Brace Assemblies
- D. Installing Fence Wire
 - 1. Barbed Wire and Woven Wire
 - 2. Chain Link Fence
- E. Gates
- F. Resetting Fences

752.04 METHOD OF MEASUREMENT

752.05 BASIS OF PAYMENT

SECTION 754 HIGHWAY SIGNS

754.01 DESCRIPTION

754.02 MATERIALS

- A. General
- B. Concrete
- C. Reinforcing Steel
- D. Delineators
- E. Hardware and Fittings
- F. Overhead Sign Structures
- G. Posts

754.03 CONSTRUCTION REQUIREMENTS

- A. Locating and Positioning Signs and Sign Structures
- B. Sign Fabrication
 - 1. General
 - 2. Fabrication of Sign Backing
 - 3. Cleaning and Processing
 - 4. Fabrication of Flat Sheet Signs
 - 5. Fabrication of Panel Signs
 - 6. Date of Fabrication
- C. Packaging, Labeling, Handling, and Shipping
- D. Label (Handling, Storage, and Installation Instructions)
 - 1. Loading on Vehicles
 - 2. Storage at Job Site
 - 3. Installation
- E. Erection of Sign Supports and Delineators
 - 1. General
 - 2. Delineator Posts
 - 3. Anchor for Telescoping Perforated Tubes and Flange Channel Supports
 - 4. Tubular Sign Supports
 - 5. Overhead Sign Structures
 - 6. Splicing
 - 7. W-Shaped Sign Supports
- F. Mounting Flat Sheet Signs Type III A and III B Sheeting
- G. Removing and Resetting Signs and Supports
- H. Remove Sign Foundations
- I. Revise Fuse Joints
- J. Overlay Panel Sign Refacing
- K. Auxiliary Signs

754.04 METHOD OF MEASUREMENT

754.05 BASIS OF PAYMENT

SECTION 762 PAVEMENT MARKING

762.01 DESCRIPTION

- 762.02 MATERIALS
- 762.03 EQUIPMENT
 - A. Paint Applicator
 - B. Grooving Equipment
- 762.04 CONSTRUCTION REQUIREMENTS
 - A. General
 - B. Pavement Surface Preparation
 - 1. General
 - 2. Plastic Pavement Marking Film
 - 3. Preformed Patterned Pavement Marking Film
 - 4. Pavement Marking Paint
 - 5. Short-Term Pavement Marking
 - C. Traffic Control
 - 1. Signing
 - 2. Traffic Movement
 - 3. Time Period for Control
 - 4. Operational Precautions
 - D. Pavement Marking Application
 - 1. Pavement Marking Paint and Glass Beads
 - a. Method of Application
 - b. Application Dates and Temperature
 - c. Rate of Application
 - d. Short-Term Pavement Marking
 - e. Short-Term Pavement Marking-Seal Coat Projects
 - f. Tolerance
 - 2. Plastic Pavement Marking Film
 - a. General
 - b. Plastic Pavement Marking Film Application
 - c. Short-Term Pavement Marking
 - 3. Preformed Patterned Pavement Marking Film
 - 4. Pavement Marking Sheeting (Pressure Sensitive)
 - 5. Raised Pavement Markers
 - 6. Epoxy Paint and Glass Beads
 - E. Inspection and Acceptance
 - 1. General
 - 2. Maintenance of Short-Term Pavement Marking
 - 3. Pay Adjustment for Short-Term Pavement Markings
 - 4. Acceptance of Epoxy Paint Pavement Marking
- 762.05 METHOD OF MEASUREMENT
- 762.06 BASIS OF PAYMENT

SECTION 764 GUARDRAIL

- 764.01 DESCRIPTION
- 764.02 MATERIALS
- 764.03 CONSTRUCTION REQUIREMENTS
 - A. General

- B. Cable Guardrail
- C. W-Beam Guardrail
- D. Removal of Guardrail
 - 1. Cable Guardrail
 - 2. W-Beam Guardrail
 - 3. Box Beam Guardrail
 - 4. End Treatment and Transition
 - 5. Miscellaneous Hardware
 - 6. Anchors
 - 7. Disposal of Unsalvageable Materials
- E. Reset Cable Guardrail
- F. Reset W-Beam Guardrail
- G. Reset Box Beam Guardrail
- H. Completion Requirements

764.04 METHOD OF MEASUREMENT

764.05 BASIS OF PAYMENT

SECTION 766 MAILBOX ASSEMBLIES

766.01 DESCRIPTION

766.02 MATERIALS

766.03 CONSTRUCTION REQUIREMENTS

766.04 METHOD OF MEASUREMENT

766.05 BASIS OF PAYMENT

SECTION 702 MOBILIZATION

702.01 DESCRIPTION.

This work consists of preparatory work and operations, including: movement of personnel, equipment, and supplies, establishment of offices, Contractor's buildings, and facilities necessary for work on the Project; and all other work and operations which must be performed, or costs incurred, before beginning work on the Project site.

702.02 PAYMENTS.

Partial Contract payments will be made for Mobilization using the following schedule:

When the listed percentage of the original Contract amount is earned, the percentage of the amount bid for Mobilization, or the percentage of original Contract amount, whichever is less, will be paid.

Amount Earned of:	Pay Lesser of:	
Total Contract	Mobilization Bid Amount	Total Contract Amount
5%	25%	2-1/2%
10%	50%	5%
50%	100%	7-1/2%
75%	100%	10%

Upon completion of all work on the Project, payment of any amount bid for Mobilization in excess of 10 percent of the original Contract amount will be paid.

SECTION 704 TRAFFIC CONTROL

704.01 DESCRIPTION.

This work consists of furnishing, installing, and maintaining all required traffic control devices according to the traffic control plan details shown on the Plans. This includes

Specifications providing for watch persons, flaggers, pilot cars, and necessary precautions for protecting the public, the workers, and the work.

All traffic control devices and their placement shall meet the standards and requirements of the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD) and the *Standard Highway Signs*, published by the Federal Highway Administration. All new and used Category I and II Traffic Control Devices shall meet National Cooperative Highway Research Program 350 (NCHRP Report 350) Guidelines.

At the Pre-Construction Conference the Contractor shall provide the Engineer a Letter of Compliance stating that all Category I and II devices are NCHRP Report 350 approved. The Letter of Compliance shall also include approved shop drawings of the signs and devices.

704.02 MATERIALS AND EQUIPMENT.

- A. **Sign Backing Materials.** Materials for sign backing shall be aluminum, steel, plywood, or plastic of the size and thickness shown on the Standard Drawings. Aluminum or steel backing shall meet and be processed according to Section 754. Plywood backing shall be of exterior grade or be overlaid with a plastic coating, and processed using recommendations of the reflective sheeting manufacturer. Plastic backing shall be processed using recommendations of the reflective sheeting manufacturer.
- B. **Reflective Sheeting.** Orange diamond-shaped, rectangular, and square signs shall be faced with Wide Angle Prismatic Fluorescent Retroreflective Sheeting meeting Section 894.02 G. Barricades and vertical panels shall be Wide Angle Prismatic Retroreflective Sheeting meeting Section 894.02 F. Flexible reflective sheeting, Type III C, shall be used on drums, cones, flexible delineators, and tubular markers. All remaining signs and sign backgrounds shall be faced with Wide Angle Prismatic Retroreflective Sheeting meeting Section 894.02 F.
- C. **Flexible Roll-Up Sign.** The flexible roll-up sign shall be mounted in a sturdy frame to keep the sign flat and in proper position for viewing by the motorist. The frame shall be attached to a portable stand for placement on the roadbed. The stand shall be weighted or designed to provide stability against wind. Flexible roll-up signs shall be fabricated to meet Section 894.02 E.2.
- D. **Flat Sheet Sign Faces.** All flat sheet sign faces, except for flexible roll-up signs as provided above, shall be fabricated to meet Section 894.01.
- E. **Barricades.** Barricades shall be constructed of light weight materials. They shall be the type and length shown on the Standard Drawings.

Both sides of the barricade rail surface shall be covered with reflective sheeting as specified.

1. **Wood Rails.** Wood rails shall meet the Standard Rules of the American Lumber Standards. Application of reflective sheeting directly on wood rails shall be made only after all edges and surfaces have been properly sanded, cleaned, sealed, resanded, and painted with a prime coat. The painted surface on which the reflective sheeting is applied shall be treated as specified by the reflective

sheeting manufacturer. In lieu of treating the painted surface to receive the reflective sheeting, sheet aluminum having a minimum thickness of 0.040 inches may be attached to the barricade rails with non-rust fasteners. The aluminum sheet shall be fabricated and degreased as provided in Section 754 before applying reflective sheeting.

2. **Aluminum Rails.** Aluminum rails shall be an extrusion of the size and shape shown on the Standard Drawings and shall meet ASTM Designation B 221, Alloy 6063-T6. They shall be fabricated and degreased as provided in Section 754 before applying reflective sheeting.
- F. **Delineator Drums.** Drums shall be approximately 36 inches in height and a minimum of 18 inches in diameter at the top. They shall be constructed of durable plastic with horizontal, circumferential, orange and white reflectorized stripes as shown on the Standard Drawings. The reflectorized stripes shall be fabricated from Type III C, Type IV, or Wide Angle Prismatic flexible reflective sheeting as provided in Section 894.02. Delineator drums shall be weighted with sand placed at the bottom of the drum or constructed so that they can not be blown over or displaced by wind or passing traffic, and do not create a hazard if accidentally struck.
- G. **Traffic Cones.** The cones shall be orange in color, shall be a minimum of 28 inches in height with a broadened base, and fabricated from materials that withstand impact. For nighttime use, cones shall have a minimum 6-inch wide white flexible reflectorized band placed a minimum of 3 inches; but not more than 4 inches from the top. An additional 4-inch white reflectorized band shall be placed a minimum of 2 inches below the 6-inch band. The cones shall be weighted at the base to prevent overturning by the wind. The reflectorized band shall be fabricated from Type III C, Type IV or Wide Angle Prismatic flexible reflective sheeting as provided in Section 894.02.
- H. **Tubular Markers and Flexible Delineators.** These devices shall be used to channelize traffic.
1. **Tubular Markers.** Tubular markers shall meet the dimensions, color configuration, and installation details as shown on the Standard Drawings.
 2. **Flexible Delineators.** The flexible delineators shall be installed in the locations shown on the plans. The posts shall be resilient and be orange in color. The delineator posts shall be made of PVC or polyethylene and shall be pre-approved for use by the Design Division. Posts currently approved are Services and Material Co. Inc., Deluxe delineator post and Safety Guide's Traf-Flex Post or Flex Stake.

The post shall have 4-inch wide white bands as shown on the plans. The reflective intensity of the bands shall meet the requirements of Type III B, Type III C, or Wide Angle Prismatic flexible reflective sheeting as provided in Section 894.02
- I. **Vertical Panels.** The vertical panels shall meet the dimensions, striping configuration, and colors shown on the Standard Drawings. The panels shall be fabricated as specified for flat sheet signs in Section 754.
- J. **Delineators.** Each delineator shall consist of an acrylic plastic or reflective sheeting reflector mounted on a post support according to the Standard Drawings.

- K. **Portable Barriers.** Precast Concrete Med. Barriers shall meet the details on the Plans or Standard Drawings. Any barriers manufactured after October 1, 2000, must meet the requirements of NCHRP Report 350. Continuing use of barriers, purchased and used on previous Department contracts, are approved throughout their useful life.
- L. **Warning Lights.** Warning lights are portable, lens directed, enclosed lights. Warning lights shall meet the requirements of the Institute of Transportation Engineers *Purchase Specifications for Flashing and Steady Burn Barricade Warning Lights*, latest revisions and the following table:

	Type A Low Intensity	Type B High Intensity	Type C Steady Burn
Lens Directional Faces	1 or 2	1	1 or 2
Flash Rate Per Minute	55 to 75	55 to 75	Constant
Flash Duration ¹	10%	8%	Constant
Min. Effective Intensity ²	4.0 Candles	35 Candles	
Min. Beam Candle Power ²			2.0 Candles
Hours of Operation	Dusk to Dawn	24 hrs./day	Dusk to Dawn

¹Length of time that instantaneous intensity is equal to or greater than effective intensity.
²These values shall be maintained within a solid angle 9 degrees on each side of the vertical axis, and 5 degrees above and below the horizontal axis.

- M. **Advance Warning Flashing or Sequencing Arrow Panels.** Advance warning flashing or sequencing arrow panels shall be used to divert and control traffic around construction or maintenance activities.

Advance warning arrow panels shall meet the following requirements:

Advance Warning Flashing or Sequencing Arrow Panel

Type	Minimum Size (in inches)	Minimum No. of Panel Lamps	Minimum Legibility Distance*
A	24 x 48	12	1/2 mile
B	30 x 60	13	3/4 mile
C	48 x 96	15	1 mile

*Minimum legibility requirements are the distances at which the arrow panel message can be comprehended by a driver on a sunny day or a clear night.

The panel face shall be solidly constructed and finished nonreflective black. Panels shall be mounted on a vehicle, trailer, or other suitable support. Vehicle-mounted panels shall be provided with remote controls.

Arrow panels shall be equipped with the following mode selection:

1. Left or right flashing or sequencing arrows, and
2. Double flashing arrows, or
3. Left or right sequencing chevrons, and

4. Caution.

Automatic light dimming controls capable of reducing rated lamp voltage a minimum of 50 percent shall be provided on each arrow panel. The dimming shall be controlled by a photoelectric cell which activates at sunup and sundown. The flashing rate of the lamps shall not be less than 25 nor more than 40 flashes per minute.

Minimum lamp “on” time shall be 50 percent for the flashing arrow and 25 percent for the sequential chevron.

The arrow panel lamps or lenses shall be recess-mounted or alternately equipped with an upper hood of not less than 180 degrees. The color of the light emitted shall be yellow.

- N. **High-Level Warning Device.** This warning device consists of a minimum of 3 flags and, when specified, a Type B high-intensity flashing light. The distance from the roadway to the bottom of the flasher lens or the lowest point of all 3 flags shall be at least 8 feet. The flags shall be a minimum of 16 inches square and shall be orange or fluorescent red-orange in color.
- O. **Flagging.** STOP/SLOW Sign Paddles shall meet the details specified in the Standard Drawings. The paddle shall be fastened to a rigid handle of five to eight feet in length. The paddle shall be fabricated from light semirigid material, and be octagonal in shape. To improve conspicuity, the paddles may be supplemented by one or two symmetrically positioned, alternately flashing, white high-intensity lamps on each side.
- When nighttime flagging is required, sufficient auxiliary lighting shall be used to illuminate the flagging station. This lighting shall be supplied by the contractor and set up in such a manner so that drivers are not blinded by it. A flashlight with a red transparent glowcone, reflectorized clothing, and a reflectorized stop-slow paddle are required for nighttime flagging operations.
- P. **Pilot Car.** The pilot car shall be a pickup truck or automobile. A 36-inch by 18-inch sign reading “Pilot Car Follow Me,” as detailed in the Standard Drawings shall be mounted on the rear of the vehicle and an oscillating or rotating yellow flashing light shall be mounted on the roof of the vehicle.
- Q. **Portable Signs.** All portable sign mounts that are in place longer than 24 hours or are in place after sunset shall be perpendicular to the ground.

704.03 CONSTRUCTION REQUIREMENTS.

- A. **General.** The Contractor shall furnish, install, and maintain all required traffic control devices, and shall provide watchpersons and flaggers as necessary to protect the work and to ensure public and workers’ safety. All required control devices shall be available for installation when needed and shall be maintained, relocated, covered, or removed as necessary. Standards for flagging shall be as specified in Section 704.03 X.

When work zone signs placed as shown on the Standard Drawings interfere with permanent signs, the work zone signs shall be moved to locations that afford the best results. Messages shall be varied as required.

The Contractor is responsible for providing the required traffic control to ensure public and worker safety. If the Contractor has not furnished, installed, located, maintained or removed one or more traffic control devices as required, the Engineer may:

1. Apply a contract price reduction of \$500 per day if deficiencies are not corrected within a 24-hour period after notification.
2. Without notification, have the deficiencies corrected by another contractor and deduct the cost of the work from monies due or to become due the Contractor.
3. Direct work to cease until the deficiencies have been corrected.

Traffic control devices shall be operated only as long as they are needed. Only those devices that apply to existing conditions shall be in place. Construction sign bases without attached signs shall be marked so they are visible.

The traffic control devices shall have breakaway supports that meet the requirements of the AASHTO Road-side Design Guide Chapter 4 Section 4.1. All signs on fixed supports shall be placed on breakaway supports, unless they are located behind a barrier or crash cushion. The Contractor shall provide documentation showing the requirements are being met for any sign supports used that do not comply with the Department's Standard Drawings.

Barricade rails and panels with stripes which begin at the upper right side and slope downward to the lower left side are designated as "right" panels and are to be used on the right side of a traffic lane. Stripes which begin at the upper left side and slope downward to the lower right side are designated as "left" panels and are to be used on the left side of a traffic lane.

- B. **Project Terminal Signing.** Before work is started, the required traffic control devices shall be erected at each end of the project and at various locations within the Project as shown on the traffic control Plan drawings. These control devices shall remain in place and be maintained for the duration of the Project. The Engineer may direct their removal during winter or other lengthy periods of suspension.
- C. **Work Area Signing.** Appropriate traffic control devices as shown on the traffic control Plan drawings shall be erected and maintained for each type of work area required by the operations. When no details are provided for the particular type of construction situation involved, traffic control devices shall be installed according to the MUTCD or as directed by the Engineer. No construction work shall be started until the proper traffic control devices for the work area are in place. If the Contractor's construction operations or sequence requires additional signing, flaggers shall be furnished at the Contractor's expense or construction operations shall be suspended in that area until the condition is corrected and the required signs have been installed.

When traffic is carried through the construction area, two-way traffic shall be maintained when practicable. One-way traffic shall be directed by flagpersons or maintained under control of an approved traffic signal system. All signs and other control devices shall indicate actual conditions and shall be relocated, removed, or changed as conditions require. Signs necessary only during hours when work is

actually being performed shall be removed or completely covered when no work is in progress.

Portable signs shall be used when construction operations in an area are temporary. Temporary operations are those that can generally be completed in five days or less. If unforeseen circumstances occur, such as equipment breakdown, rain, subgrade failures, etc., time will not accrue towards the five-day period.

When portable signs are used, they shall be placed on the shoulder or outside of the traveled lane where they do not pose a hazard to traffic. The portable signs shall be placed in clear view without any sight obstructions to oncoming traffic. When portable signs are not in use, they shall be removed, moved to a minimum of 45 feet from the edge of the traveled lane, or laid down on the inslope. Signs laid on the inslope shall have stand bases constructed so the signs and bases can be placed flat with no portions of the sign or base projecting upward from the inslope more than 6 inches. When it is necessary to place a temporary sign on a paved surface, the sign may be mounted on portable supports for longer than five days.

The portable signs support assembly mounted on trailers shall meet the requirements as specified above for portable signs except as follows. The portable signs mounted on trailers that have passed the crash test required of NCHRP Report 350, as approved by the FHWA, shall be used. When portable signs mounted on trailers are used, they shall be removed, moved a minimum of 45 feet from the edge of the traveled way, or covered so the sign message cannot be read by approaching vehicles.

- D. **Existing Signs.** Existing regulatory traffic signs which must be moved to accommodate construction shall be immediately reset.

The cost to remove and reset existing traffic signs to accommodate construction shall be included in the price bid for other items.

- E. **Route Markers.** Route marker signs required for the Project and for Contractor-maintained detours will be furnished by the Department and shall be installed by the Contractor on supports furnished by and at the Contractor's expense.
- F. **Detour Signing.** The Contractor shall furnish, install, and maintain all traffic control devices for detours.
- G. **Highways Closed to Traffic.** When a detour is provided and traffic is not maintained through the construction area, necessary access to property abutting the Project shall be provided by constructing and maintaining temporary roads and approaches from the nearest crossroad. Traffic shall not be routed over detours not provided in the Contract documents without written authorization from the Engineer.
- H. **Restricted Speed Zones.** Restricted speed zones and the speed limit to be posted for such zones will be designated in the Contract documents or determined by the Engineer.
- I. **Temporary Suspension.** During a temporary suspension of work, the Contractor is responsible for maintaining and protecting traffic. When operations are suspended for the winter or are indefinitely suspended for reasons beyond the Con-

tractor's control, the roadway and the traffic control devices will be maintained by and at the Department's expense.

Before suspending operations for the winter, adequate approaches shall be constructed to all crossroads or intersecting roads which have been disturbed by construction operations. Access to the roadway from abutting property shall also be provided. Warning signs, barricades, and other traffic control devices shall be erected (or existing devices removed) as directed by the Engineer. Resetting of signs removed because of a winter suspension will not be measured for payment.

- J. **Barricade Application.** Type I or Type II barricades shall be used as shown in the traffic control plan details where traffic is maintained through the construction area. They may be used singly or in groups to mark a specific hazard, or used in a series to channelize traffic and shall not be set parallel to traffic. On high-speed roads or in situations where barricades may be overturned in the wind, the barricades shall be stabilized with sandbags placed on the lower parts of the frame or stays.

When a section of road is closed to traffic, Type III barricades shall be erected at the points of closure. They shall extend completely across the roadway and shoulders or from curb to curb. Where provision must be made for access of equipment and authorized vehicles, the Type III barricades shall be provided with gates or movable sections that can be closed when work is not in progress, or with indirect openings that discourages public entry. Where access is provided through the Type III barricade, an employee shall be designated to assure proper closure at the end of each working day.

When a road or street is closed, but access to local traffic must be furnished, the Type III barricades shall be arranged to permit local use but discourage through traffic. A sign with the appropriate legend concerning use by local traffic shall be installed.

Type III barricades shall be installed at the beginning and end of the project when so indicated in the Contract documents and shall not be placed parallel to traffic.

The required warning signs shall be mounted above the barricades.

If the construction zone encroaches onto sidewalks or crosswalks and pedestrians cannot be diverted to other walkways, barricades may be used to define the path.

- K. **Drum Application.** Drums shall be used to channelize or delineate traffic flow, and may be used singly or in groups to mark specific hazards. When drums are placed in the roadway, advance warning signs are required.
- L. **Traffic Cone and Tubular Marker Application.** Traffic cones and tubular markers used to channelize traffic shall have adequate stability to prevent overturning or displacement by wind. Additional weighting may be required but shall not be so heavy to cause a hazard if struck.
- M. **Flexible Delineator Application.** The delineator base shall be attached to the pavement as shown on the Plans. The Contractor shall maintain the delineators until they are removed. The delineators shall be removed as soon as the new roadway is opened to traffic. The flexible delineators shall remain the property of the Contractor.

If the Contractor uses a two-sided delineator, the delineator shall have the wide side towards traffic. If the delineator is to be seen by side traffic, an additional delineator shall have the wide side placed facing the side traffic. The side traffic delineators shall not be paid for, but shall be included to the price bid for "Flexible Delineators."

If the Contractor uses the butyl pad for attaching the flexible delineator to concrete roadways, the contractor shall remove the butyl pad down as close as possible to the pavement using a mechanical scraper such as a loader-type machine with a bucket.

All costs for providing, installing, maintaining, and removing the flexible delineators with butyl pad when used shall be included in the unit price bid for "Flexible Delineators."

- N. **Vertical Panel Application.** Vertical panels shall be used as channelizing devices, warning devices, or windrow markers. Vertical panels shall be faced on both sides.
- O. **Delineator Application.** Delineators shall be used in construction areas for guidance, to indicate roadway alignment, and to outline the required vehicle path. Delineators shall not be used as warning devices and, when used in a construction zone, shall be combined with approved warning devices.

Delineators shall be mounted on supports so the reflector is 4 feet above the roadway edge. White reflectors shall be used for delineators installed along the right side of the street or highway. Yellow reflectors shall be used for delineators installed along the left edge of divided streets, divided highways, and one-way roads.

Delineator spacing shall be as indicated on the traffic control plan sheets. Along roadway curves, delineators shall be spaced so that several delineators are always visible to the driver.

- P. **Portable Barrier Application.** Traffic control plan sheets may require, or the Contractor may elect to use, portable barriers to separate the work area from the traffic area. For nighttime use, the barriers shall be supplemented by standard delineators or channelizing markings or devices.

When specified, warning lights shall be installed on continuous barriers. The first two warning lights on each side of the roadway shall be Type A flashers, and subsequent lights on the barrier shall be Type C steady burn lights.

The Contractor shall furnish, install, maintain, and remove barrier markers as specified in the Plans. The costs shall be included in the price bid for "Precast Concrete Median Barriers - State Furnished" or "Precast Concrete Median Barriers."

The ends of the barrier shall be protected by crash cushions or by flaring the barrier ends away from the traveled way as shown in the Contract.

- Q. **Lighting Device Application.** Lighting devices shall be provided as required on the traffic control plan sheets to supplement signs, barricades, and other traffic control devices.

1. **Type III or IV Reflective Sheeting.** Flashing lights and steady burn lights on signs, drums, vertical panels, and barricades are not required when Type III, Type IV, or wide angle prismatic reflective sheeting is used.
 2. **Flashing Lights (Type A, Low-Intensity).** Type A low-intensity flashers shall be used to warn drivers that they are approaching or traveling in a hazardous area.
 3. **Flashing Lights (Type B, High-Intensity).** Traffic control plan sheets require installation of high-intensity flashers at extremely hazardous site conditions. The high-intensity flashers shall be operated 24 hours per day.
 4. **Steady-Burn Lights (Type C).** The steady-burn warning lights shall be used to delineate the edges of the traveled way on detour curves, on lane changes, and along tapers. Spacing of steady-burn lights shall be as indicated on the traffic control plan sheets.
 5. **Mounting Height of Warning Lights.** The mounting height of warning lights shall be as follows:
 - a. **Barricade and Portable Standards.** A minimum height of 36 inches from the bottom of the lens to the roadway.
 - b. **Signs.** The bottom of the light housing shall not be less than 2 inches nor more than 12 inches above the top of the sign.
 - c. **Vertical Channelizing Devices and Independent Supports.** The light shall be at least 4 feet and not more than 5 feet above the pavement.
 6. **Advance Warning Arrow Panels.** The sequencing arrow panels shall be used to provide advance warning and directional information to assist in diverting and controlling traffic around construction activities being conducted on or adjacent to the traveled way. Other traffic control devices may be required in conjunction with the sequencing arrow panel. During nighttime operation of the flashing arrow panels, the lamps shall be automatically dimmed to 50 percent of the output.
 7. **Floodlights.** If construction activities are performed at night, floodlighting shall be provided for the construction area and flagger stations. The area must be adequately illuminated without creating glare in the eyes of drivers.
- R. **High-Level Warning Device.** High-level warning devices shall be used to supplement other controls and devices and shall be required in urban high-density traffic situations.
- S. **Obliteration of Pavement Marking.**
1. Removal of existing marking and installation of short-term marking shall be as shown on the traffic control plan sheets. Inappropriate existing markings shall be removed and the new delineation placed before opening the affected lane or lanes to traffic.

Removal of pavement markings shall not permanently damage the surface or texture of the pavement. Where blast cleaning is used for removal of mark-

ings or other objectionable material, the sand or other blast material left on the pavement shall be removed immediately.

2. Painting over or masking existing markings shall be allowed only when indicated in the Plans. Obliteration of the pavement markings by use of grinding or a sandblasting method will not be allowed when painting or masking of existing pavement markings is indicated in the Plans.

Paint shall be mixed so as to closely approximate the color of the in-place pavement. Masking shall be done through the use of removable, non-reflective, preformed tape that minimizes contrast with the pavement. When existing markings are covered rather than obliterated, the cover shall overlap the existing marking by 1 inch on each side.

- T. **Construction Zone Marking.** Yellow short-term marking shall be used to delineate traffic flow in opposing directions or mark the left edge of the pavement of divided highway or one-way roads. White short-term marking shall be used to delineate the separation of traffic flow in the same direction or mark the right edge of the pavement. The short-term markings shall be used in combination with appropriate warning signs, channelizing devices, and delineation to clearly indicate the required vehicle paths.

U. **Traffic Control Personnel.**

1. **Traffic Control Supervisor.** When called for on the Plans, the Contractor shall designate a qualified traffic control supervisor.

If this traffic control supervisor becomes unavailable on the project, the Contractor shall designate a qualified replacement supervisor.

- a. **Qualifications.** The traffic control supervisor shall:

- (1) Have completed a Department-approved comprehensive course of study based on Part VI of the MUTCD and furnish proof thereof.
- (2) Be familiar with the requirements of the Department traffic control plans and specifications.
- (3) Have a total of at least 12 months field experience with traffic control plans, layouts and maintenance.
- (4) Be competent to supervise personnel in traffic control operations.

- b. **Duties.** The traffic control supervisor shall:

- (1) Provide traffic control as required by the Plans, Specifications, MUTCD, or as directed by the Engineer.
- (2) Be on the site daily to supervise the installation, operation, inspection, maintenance, and removal of the traffic control system.
- (3) Correct traffic control conditions that cause erratic vehicle movements, unexpected braking, etc.

- (4) Propose changes to improve traffic flow through the work zone.
- (5) Be accessible to the job site within one hour of notification and be “on call” on a 24-hour basis.
- (6) Provide the Engineer with documentation of all traffic control activities required in paragraph (2) above.
- (7) May perform watchperson duties, as specified in Section 704.03 U.2.

- c. **Traffic Control Course.** The course prescribed in Section 704.03 U.1.a(1) above shall be the American Traffic Safety Service Association (ATSSA) 16-hour Traffic Control Supervisor Course, American General Contractor (AGC) 16-hour Traffic Control Supervisor Course, or the 20-hour National Highway Institute (NHI) Course 380003, Design and Operation of Work Zone Traffic Control, or equal.

An equal course shall include the following subjects: Manual and Standard Signs used in Work Areas (three hours); Channelizing Devices and Temporary Barriers, Pavement Markings, Lighting Devices, Arrow Displays and Special Devices, and Devices Location and Placement (four hours); Layout for Traffic Control Devices, Motorist Characteristics, and Options and Alternatives (four hours); Installation and Removal of the Traffic Control Zone, and Operation and Maintenance of the Traffic Control Zone (four hours); Flagging Operations, Legal Liability and Record Keeping, and Emergency Situations (five hours).

Workshops shall be included in the above time frames covering (a) design problems, (b) installation and removal, and (c) operations and maintenance. Each session shall also include a question and answer period.

2. **Watchpersons.** Watchpersons shall be provided to patrol the project to assure that the traffic control devices are properly placed in accordance with the traffic control plans and standards. The project shall be patrolled at least twice daily, once in the morning prior to work beginning and once in the evening after work is completed. The project shall also be patrolled twice daily on weekends and days when no work is in progress, once each morning and once each evening before sunset.

The Contractor shall provide written documentation to the Engineer of the watchperson’s hours and activities.

The Contractor shall immediately assist the watchperson, whenever needed, to correct conditions that cause erratic traffic movement, unexpected braking, etc., and erect, repair, replace, or relocate the required traffic control devices. Emergency assistance shall be provided to motorists, when needed, due to roadway conditions. Suspension of watchperson service may be permitted during periods of authorized suspension or after substantial completion of the work, provided the job site is in safe condition.

3. **Traffic Signal Maintenance.** On projects where permanent or interim traffic signals are being installed, the Contractor shall designate an experienced per-

son in this area that can troubleshoot any possible problems that may occur with the traffic signal maintenance. This maintenance person shall be in addition to the traffic control supervisor and the watchperson as specified in Sections 704.03 U.1 and 704.03 U.2.

The traffic signal maintenance person, or experienced alternate, must be accessible to the job site within one hour of notification and be “on call” on a 24-hour basis. In the event of emergency control, refer to Section 704.03 V.

The Contractor shall be required to maintain the interim or permanent traffic signals until the project has been accepted by the Engineer.

- V. **Emergency Control.** Written notification shall be provided to the Engineer, the Highway Patrol, and local law enforcement agencies, of the names, addresses, and the telephone numbers of the Contractor’s Superintendent, an alternate for the Superintendent, Traffic Control Supervisor, Watchperson, and the Traffic Signal Maintenance Person. Either the Superintendent or the alternate shall be on call for notification of any emergencies that may arise during periods when construction operations are not in progress. Changes in the designation of the Superintendent or the alternate shall immediately be made known, in writing, to the Engineer and the law enforcement agencies.

The Contractor’s Superintendent or alternate, or traffic control foreman shall meet with the Engineer before work commences to review traffic control plans, and shall be available at all times to periodically discuss modifications to the traffic control plan with the Engineer or his representative.

When an emergency occurs and the Superintendent or alternate are not available to take protective or corrective measures, the Department will authorize others to do the necessary work and deduct the cost of the work from the Contractor.

- W. **Maintenance of Traffic Control Devices.** Traffic Control Devices used on the Project will be rated according to the American Traffic Safety Services Association’s (ATSSA) *Quality Standards for Work Zone Traffic Control Devices*. The definitions of “acceptable,” “marginal,” and “unacceptable” and the evaluation guidelines shall be as defined in ATSSA’s *Quality Standards for Work Zone Traffic Control Devices*.

Except when devices are to become Department property (as indicated below), at the time of initial set up and major phase changes, 100 percent of each type of device (signs, barricades, vertical panels, drums, cones, tubular markers, warning lights, arrow panels, etc.) shall be classified as acceptable. The Contractor shall certify in writing to the Engineer that all traffic control devices installed are classified as acceptable.

When the Plans indicate that temporary traffic-control devices are to become Department property, these devices shall be new upon delivery to the Project and be classified acceptable upon Project completion.

For signs, barricades, vertical panels, drums, cones, tubular markers, and arrow panels the number of acceptable devices of each type may decrease to 75 percent of the initial quantity as a result of damage or deterioration during the course of work. The remaining 25 percent of each type of devices may be in the marginal

category. Warning lights shall be “acceptable” or “marginal” at the limits defined in the ATSSA standards. All unacceptable devices found on the job site shall be replaced within 12 hours.

Traffic control devices not covered by the evaluation guidelines shall be maintained to operate effectively and be in good repair.

Traffic control devices shall be cleaned as necessary to remove dirt, mud, or other foreign material which reduces the brightness of the reflectorized sheeting or warning lights.

- X. **Flagging.** Flaggers shall be clean, neat, and fully dressed at all times while on duty either day or night. For daytime work, the flagger’s vest, shirt, or jacket shall be orange, yellow, strong yellow green, or fluorescent versions of these colors. For nighttime work, similar outside garments shall be retroreflective. All flagger’s vests shall meet ANSI 107-2004 Class 2 or Class 3 risk exposure requirements, when applicable. The retroreflective material shall be orange, yellow, white, silver, strong yellow-green, or a fluorescent version of one of these colors and shall be visible at a minimum distance of 1,000 feet. The retroreflective clothing shall be designed to identify clearly the wearer as a person and be visible through the full range of body motions.

Each flagger shall be furnished with the booklet, *Flagging Handbook*, and shall observe the rules and regulations contained therein. The Contractor shall obtain copies of the *Flagging Handbook* from the Department.

Flaggers shall not be assigned other duties while working as authorized flaggers.

The Contractor is responsible for providing trained flaggers. All flaggers must view a flagging video training tape and pass a flagging written examination before performing flagging on the project. The Contractor will acknowledge in writing, before any flagging work begins on the project, that all flaggers will have viewed a flagging video tape and passed a written examination before performing flagging on the project.

- Y. **Pilot Car.** A pilot car shall be used to guide vehicles through or around the construction area when traffic is reduced to a single-lane. The pilot car operation must be coordinated with flagging operations or other controls at each end of the one-lane section.
- Z. **Flag Application.** Flags shall be attached to warning signs if indicated in the traffic control plan sheets.

704.04 METHOD OF MEASUREMENT.

- A. Individual traffic control items shall include furnishing, installing, maintaining, relocating, and removing as dictated by the work in progress and will be measured for payment as follows:
1. **Traffic Control Signs.** Traffic Control Signs will be measured by the unit and will be inventoried when complete, in place, and accepted by the Engineer. All posts and mounting hardware required to complete the installation will be included in the pay item. The total units of Traffic Control Signs

shown in the Plans is estimated and may be adjusted according to the needs of the Project.

2. The following devices will be measured by the number of each installed, complete, in place, and accepted by the Engineer:
 - a. Barricades (by type)
 - b. Delineator Drums
 - c. Traffic Cones
 - d. Delineators
 - e. Flexible Delineators
 - f. Vertical Panels
 - g. Sequencing Arrow Panels (by type)
 - h. Tubular Markers

No measurement will be made of devices which are installed without being authorized by, or directed by, the Engineer.

- B. Traffic Control.** When “Traffic Control,” is included in the Contract as a lump sum, it includes all traffic control necessary for the project construction except as otherwise provided. Payment includes furnishing, installing, and maintaining the required signs, barricades, and other warning devices; relocating or removing devices as dictated by the work progress; and providing watchpersons to patrol the work.

No payment (over the lump sum bid for “Traffic Control”) will be authorized for additional traffic control devices required as a result of the Contractor’s method or sequence of operation, whether or not the type of operation is included in the typical work area layouts shown on the traffic control plan sheets.

Payment (over the lump sum bid for “Traffic Control”) may be authorized for additional traffic control devices if the type or number of such devices requested by the Engineer exceeds the requirements indicated by the typical work area layouts shown on the traffic control plan sheets, or when the need for additional traffic control devices is created as a result of Contract revisions.

- C. Obliteration of Pavement Marking.** Obliteration of Pavement Marking will be measured according to Section 762.05 E., and paid for according to Section 762.06.
- D. Flagging.** Flagging will be measured by the hour of authorized flagging. Authorized flagging shall be the actual hours of flagging authorized by the Engineer.
- E. Pilot Car.** Pilot Car, when included in the Contract as a separate bid item, will be measured by the hours of pilot car use as authorized by the Engineer.

704.05 BASIS OF PAYMENT.

- A.** Payment for Traffic Control Signs will be made following proper installation of the signs. Payment for each Traffic Control Sign will be its unit value listed in the

Plans multiplied by the Contract Unit Price per unit. Payment will be full compensation for all labor, equipment, and materials necessary to complete the work as specified.

If signs mounted on fixed supports must be relocated due to a change of Plans or as directed by the Engineer, the Contractor will receive a relocation payment in the amount of 50 percent of the payment for the installed signs as determined above.

Unless otherwise shown on the Plans, additional payment will not be made for any existing Traffic Signs, Traffic Control Signs, and other devices turned away, covered up, taken temporarily out of service, and then returned to use; or for any signs and devices relocated as required by construction operations.

If the Contractor is required to furnish special non-standard signs not shown on the Plans, a unit value agreeable to the Contractor and the Department will be established for such signs, and payment will be made according to the Contract Bid Price per sign unit. If a unit value cannot be agreed upon, payment will be made at invoice price plus 15 percent, and the sign will become the Department's property after it has been removed from service. Payment for sign supports and installation of special signs will be made using the prices listed in the *Rental Rates for Equipment and Traffic Control Devices*, published by the Department.

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Traffic Control Signs	Unit
Type I Barricade	Each
Type II Barricade	Each
Type III Barricade	Each
Delineator Drums	Each
Traffic Cones	Each
Delineators	Each
Flexible Delineators	Each
Vertical Panels	Each
Sequencing Arrow Panels, Type__	Each
Remove and Reset Existing Traffic Signs	Each
Tubular Markers	Each
Precast Concrete Median Barrier (State furnished)	Each
Portable Precast Concrete Median Barrier	LF

The Contractor will be paid the Contract Unit Price for the above items when the devices have been properly installed and have been accepted by the Engineer.

No payment will be made for devices added or relocated without authorization of the Engineer.

Devices removed from the Project without approval of the Engineer shall be replaced as directed at the Contractor's expense.

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

- B. When the item "Traffic Control" is bid as a Lump Sum, payment for the Contract Lump Sum bid will be made according to the following schedule:

**Total Payment
to Date**

- 40% - When all initial traffic control devices required to start construction have been installed.
- 50% - When Contract is 25% complete.
- 75% - When Contract is 50% complete.
- 90% - When Contract is 75% complete.
- 100% - When Contract is complete.

When additional traffic control devices requested by the Engineer qualify for payment according to Section 704.04 B, payment for furnishing and installing such devices will be made using the prices listed in the *Rental Rates for Equipment and Traffic Control Devices*, published by the Department.

The above payments for installation include the cost of removing or relocating the traffic control devices. No additional payment will be made when traffic control devices are covered up, or temporarily taken out of service, then returned to use.

All standard traffic control devices furnished by the Contractor shall remain the property of the Contractor.

If the Contractor is required to furnish special non-standard signs not shown on the Plans, payment will be made at invoice price plus 15 percent, and the sign will become the Department's property after it has been removed from service. Payment for sign supports and installation of special signs will be made using the prices listed in the *Rental Rates for Equipment and Traffic Control Devices*, published by the Department.

- C. Obliteration of Pavement Marking, when included in the Contract as a separate pay item, will be paid for according to Section 762.06.

When no pay item is provided, the Obliteration of Pavement Marking will be paid for under Section 104.03.

- D. Flagging will be paid for at the Contract Unit Price per hour for the total authorized hours of flagging as measured in Section 704.04.
- E. Pilot Car will be paid for at the Contract Unit Price per hour for the total hours authorized by the Engineer.
- F. Items requested by the Engineer that are not listed on the Plans or Standard Drawings as incidental items or separate pay items such as Flashing and Steady Burn Lights, Concrete Median Barriers, Attenuation Devices, etc., will be paid for under Section 104.03.
- G. The cost of providing Traffic Control Supervisors, when needed, and Watchpersons shall be included in the bid prices for other items.
- H. When there is a bid item which includes precast concrete median barriers (barriers) which are furnished by the state, payment will be made in accordance with the following schedule:

50 percent of the bid amount will be paid when:

The barriers have been placed on the project site in accordance with the Plans and all other applicable requirements of this section have been satisfied.

The remaining 50 percent of the bid amount will be paid when:

The barriers have been removed from the project, transported to the storage area designated in the Plans, have been determined to be in serviceable condition, and all hardware is accounted for as shown in the written inventory. Acceptability and full payment will be as determined by the Engineer.

The Engineer shall be informed a minimum of two weeks prior to the date that the Contractor plans to take control of the barriers. Prior to the Contractor taking control of the barriers, the Contractor and the Engineer shall take a written inventory of all barriers and associated materials to be received by the Contractor. The Contractor and the Engineer shall each sign, date, and retain a copy of the inventory.

The Engineer shall be informed a minimum of two weeks prior to the date that the Contractor plans to transport the barriers to the location designated in the Plans for storage. Upon delivery to the site, the Contractor and Engineer shall take an inventory of the barriers and associated materials being returned to the control of department. Any barriers that have been damaged and any associated materials that have been lost or damaged while under the control of the Contractor shall be replaced at the Contractor's expense.

The cost of obtaining, transporting, installing, moving, and maintaining the barriers shall be included in the state furnished precast concrete median barrier bid item.

SECTION 706 FIELD LABORATORY

706.01 DESCRIPTION.

This work consists of furnishing and placing a field laboratory as specified.

706.02 REQUIREMENTS.

The Contractor shall locate the lab at a location that will allow use of lab equipment without interference from the plant operations. The building shall be under the full control and for the exclusive use of the Engineer. The building shall be located and relocated as needed as the work progresses. Each laboratory shall be supplied with an operable fire extinguisher. Outside doors shall be equipped with latches, locks, and screen doors. The field laboratory may be removed from the Project when released by the Engineer.

The building and fixtures shall remain the property of the Contractor after the work is completed.

A. Type A, Field Laboratory.

The building shall be fully insulated and watertight with a floor area of not less than 120 square feet and a minimum ceiling height of 7 feet.

The building shall be equipped with a solid workbench that has a minimum width of 24 inches, minimum total length of 10 feet, and a height of from 36 inches to 42 inches.

Windows shall be located on at least two sides of the building. A minimum of two light fixtures and four outlets shall be installed. Heating arrangements shall have sufficient capacity to maintain a minimum temperature of 70°F. Running water shall be provided at a faucet in the building. A sink shall be provided with means of disposal for the waste water.

B. Type B, Field Laboratory.

The building shall be completely insulated, weather tight, have a minimum floor area of 230 square feet, minimum exterior width of 8 feet, and a minimum ceiling height of 7 feet.

The building shall be partitioned to provide a drying room having an area of approximately 70 square feet. The room shall have 7 feet of workbench, one window, and an exhaust fan that is capable of changing the air in the room every minute.

The building shall have a minimum of six screened windows, and they shall be placed on two or more sides. Each window shall have a minimum area of 4 square feet.

A dependable source of electricity for power and lights shall be furnished. There shall be a minimum of six electrical outlets spaced throughout the building and three light fixtures spaced to uniformly light the entire interior.

A constant water supply shall be furnished with a minimum pressure of 5 psi or a minimum head of 12 feet when a gravity tank is used. A faucet and sink shall be provided in the workbench area.

The building shall be equipped with solid workbenches with a minimum width of 24 inches, length of 30 feet, and a height of from 36 inches to 42 inches. The building shall have a chair and a table or desk.

The heating system shall be capable of maintaining a minimum temperature of 70°F. The main part of the building shall be equipped with an air conditioner that can maintain a temperature below 80°F.

A microwave oven shall be provided with the following minimum requirements:

1. 30 minute timer.
2. Three-position power control (full power, slow-cook, defrost).

3. 900 Watts of cooking power.
4. 1 cubic foot usable oven capacity.
5. Removable glass oven tray.

A conventional 30-inch range shall be provided. The oven shall be a thermostatically-controlled drying oven capable of maintaining temperatures of $230^{\circ} \pm 9^{\circ}\text{F}$. ($110^{\circ} \pm 5^{\circ}\text{C}$).

C. Type C, Field Laboratory.

On bituminous paving projects, the Contractor shall locate the lab at a location at the plant site, unless approved by the Engineer. The Contractor shall provide a mechanical Marshall compactor equipped with an automatic counter, three compaction pedestals, three specimen molds, three mold holders, and three compaction hammers with a 1 degree bevel.

The minimum floor area shall be 320 square feet. The minimum exterior width shall be 8 feet, and the minimum ceiling height shall be 7 feet.

The building shall be partitioned into two rooms with a connecting door and a door to the outside in each room. The sill plate of the outside door shall be no more than 3 feet above the ground.

There shall be a minimum of six exterior windows. The minimum total area of exterior window opening shall be 34 square feet.

The building shall be furnished with a minimum of the following built-in facilities:

1. Desk with drawers.
2. Cabinets with shelves and doors.
3. Work counters.
4. Double sink with drain and water connection.
5. Closet with shelf and clothes bar.

The building shall be equipped with a constant and dependable source of electricity for power and lights 24 hours a day. Light fixtures shall be placed to adequately light all work counters and the interior of the building. Electrical outlets shall furnish the amperage rating listed on the Standard Drawings for each outlet.

The building shall be equipped with an outside water storage tank of 500 gallon minimum capacity. In addition, a 20-gallon capacity pressure tank shall be furnished and connected to the sink. The pressure tank shall draw from the storage tank and supply water to the sink at a minimum 5 psi pressure. The drain from the sink shall be connected to an outside waste line.

The building shall be fully-insulated and weather tight. A heating system shall be furnished that is capable of maintaining a minimum 70°F . in the building. An air

conditioning system shall also be furnished that is capable of maintaining a temperature of below 80°F.

A microwave oven and a conventional range and oven shall be provided with the same minimum requirements as stated in Section 706.02 B.

On bituminous paving projects, the Contractor shall provide a mechanical Marshall compactor equipped with an automatic counter, three compaction pedestals, three specimen molds, three mold holders, and three compaction hammers with a 1 degree bevel. The compactor shall be a model H-1356, Marshall Triple Mechanical Compactor, as manufactured by Gilson and Pine, Humboldt Mfg. Co., or be an approved equal. The compactor shall be capable of compacting triplicate specimens simultaneously. The Contractor also shall provide another compaction pedestal, specimen mold assembly and mold holder for calibrating the mechanical compactor. All of the equipment provided shall be furnished and set up by the Contractor and shall meet the requirements of AASHTO T 245.2.

The Department may calibrate the mechanical compactor at any time with a hand-held hammer provided by the Department. The mechanical hammer shall be adjusted if the average specific gravity of three specimens, compacted at one time with the triple mechanical compactor, is not within 0.020 of the average specific gravity of three specimens compacted with the hand-held hammer.

The Contractor may place the mechanical hammer outside or in the field lab. The Marshall hammer shall be bolted to a concrete slab a minimum of 3 feet × 3 feet × 6 inches in size. If the hammer is placed outside the concrete slab shall be placed level on the ground, on a sand base. If the hammer and concrete slab are placed in the lab, the Marshall area shall be shored to prevent vibration and deflection in the floor. The floor shall be supported with steel beams placed below the concrete slab. The beams shall be placed against the floor; an air space between the beams and the floor will not be allowed. The beams shall be supported with jacks placed below the Marshall area. The jacks shall be placed on a level concrete slab a minimum of 4 inches thick.

The Type C Field Laboratory shall be equipped with the following laboratory equipment :

1. Two filtering flasks, 2000 ml, heavy wall graduated.
2. A vacuum pump capable of evacuating air from filtering flask to a residual pressure of 30 mm Hg (4.0 kPa).
3. A vacuum gauge capable of measuring a minimum of 30 mm Hg (4.0 kPa) of pressure.
4. Orbital shaker with orbit size of 0.75 in (19 mm) and a stirring speed range from 40 to 400 RPM. Top plate large enough to accommodate two 2000 ml filtering flasks. Two clamps for platform to hold flasks in place. Orbital shaker equivalent to Thermolyne, Model No. M49125.
5. Electronic balance with a 5,000 g, capacity capable of weighing to the nearest 0.1 g. Balance shall be equipped with a suitable suspension apparatus and holder to permit weighing of the sample in water.

- 6. A set of Standard Calibration Weights.
- 7. A thermostatically controlled water bath capable of heating or cooling to maintain a water temperature of $77^{\circ} \pm 1^{\circ}\text{F}$. with an overflow system for maintaining a uniform water level. A recirculation system with on/off controls is also required. The water bath should maintain a minimum of five gallons of water.
- 8. Insulated container for transporting mix from paver to field laboratory. Insulated container shall be large enough to accommodate 22 pounds of mix in pails or other type container.
- 9. Extrusion Jack capable of removing the plug from the marshall mold without deforming the plug.

706.03 METHOD OF MEASUREMENT.

Each laboratory will be measured as a unit complete and in place.

706.04 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Field Laboratory Type ____	Each

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

**SECTION 708
EROSION CONTROL**

708.01 DESCRIPTION.

This work consists of furnishing and installing temporary and permanent erosion control measures which include seeding, placing sod, mulch cover, soil retention blankets, riprap, formed fabric, concrete slope protection and other measures as specified.

708.02 SEEDING, SODDING, AND MULCHING.

- A. **Description.** This work consists of laying sod, seeding, and if specified, placing a mulch cover.
- B. **Materials.**
 - 1. **Seeding.**

- a. **General.** The seed furnished shall be the species and varieties specified and shall meet or exceed Pure Live Seed requirements. Seed and seeding mixture shall be free of all prohibited noxious weed seed and shall not contain more than 1/2 of 1 percent by weight of restricted noxious weed seeds. Prohibited and restricted noxious weeds shall be those as classified by the North Dakota State Seed Department.

Seed which has become wet, moldy, or damaged in transit or in storage will not be accepted.

- b. **Seed Testing.** All seed shall be tested within nine months before the planting date. The Contractor shall have the testing performed by a State Seed Lab, Commercial Seed Testing Lab, or a registered member of the Society of Commercial Seed Analysts. A certified test report shall be furnished to the Department before the seeding operation starts. Seed not planted within the nine-month period shall be retested for dormant seed, hard seed, and germination, and a new certified test report furnished.
- c. **Labeling.** Each bag of seed delivered to the Project shall bear a tag which shows the following information:
- (1) Name and address of supplier.
 - (2) Supplier's lot number for each kind of seed in the mixture.
 - (3) Origin (where grown) for each kind of seed.
 - (4) Purity and germination for each kind of seed.
 - (5) Date of latest test.
 - (6) Pounds of bulk seed of each kind of seed in each bag.
 - (7) Total pounds of bulk seed mixture in each bag.
 - (8) Pounds of pure live seed of each kind of seed in each bag.
 - (9) Total pounds of pure live seed mixture in each bag.
- d. **Seed Classes.** The class of seed and the minimum amount of seed per acre shall be as follows:

Grass Species	Variety	Pounds Pure Live Seed Per Acre
<u>Class I</u>		
Western Blue Grass	Park	40
Perennial Rye Grass	--	10
<u>Class II</u>		
Western Wheatgrass	Rodann or Rosanna	8
Switchgrass	ND-965-98, Nebraska 28, or Sunburst	4
Green Needlegrass	Lodorm	6
Sideoats Grama*	Killdeer or Pierre	6
Slender Wheatgrass	Revenue or Primar	<u>5</u> 29
<u>Class III (Hydro-Mulch)</u>		
Western Wheatgrass	Rodann or Rosanna	8
Switchgrass	ND-965-98, Nebraska 28, or Sunburst	4
Green Needlegrass	Lodorm	6
Sideoats Grama*	Killdeer or Pierre	6
Slender Wheatgrass	Revenue or Primar	<u>5</u> 29

Seed for Hydro-Mulch in urban areas shall be Class V.

Class IV (Temporary Cover Crop)

Oats	30
Rye	50
Winter Wheat	50

Class V (As specified on the Plans)

Class VI

Oats	15
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*If Sideoats Grama is unavailable, Thickspike Wheatgrass of the Critana or Elbee variety may be substituted.

Seed for the reseeding of small areas damaged during construction or maintenance operations shall be as specified on the Plans.

e. **Fertilizer Requirements.**

- (1) **Class I, II, and V.** A fertilizer mixture shall be applied that furnishes a minimum of 20 pounds of Nitrogen (N) and 20 pounds of Phosphorous (P₂O₅) per acre.
- (2) **Class III.** The fertilizer to be used when Hydro-Mulch seeding is specified shall be a mixture of 20-20-0 and urea formaldehyde (36-0-0). It shall be uniform and delivered in bags or other containers, labeled according to state law and bearing the name, trademark

or trade name, and warranty of the producer. The 20-20-0 shall be applied at a rate assuring 20 pounds of actual Nitrogen (N) and 20 pounds of actual Phosphorus (P₂O₅) per acre. The urea formaldehyde shall be applied at a rate of 60 pounds per acre assuring 20 pounds of actual Nitrogen (N) per acre.

2. Sodding.

- a. **General.** Sod shall consist of dense well-rooted growth of permanent and desirable grass, native or adapted to the general locality where it is to be placed, such as Kentucky Blue Grass. The sod shall be free from weeds or undesirable grasses. When the sod is cut, the grass shall be no longer than 2 inches.

The sod shall be uniform in thickness, and shall not tear or break when being handled or placed.

- b. **Peat Sod.** Peat sod will not be allowed. Peat sod is defined as that which contains more than 20 percent organic material as determined by test method AASHTO T 267.
- c. **Sampling, Testing, and Certification.** The Contractor shall submit to the Engineer a "Certificate of Compliance" from a recognized independent testing laboratory stating that the soil upon which the furnished sod was grown does not contain more than 20 percent organic matter. The percentage of organic matter shall be determined according to the latest version of AASHTO test method T 267. The certification, or a copy, shall accompany each shipment of sod to the project.

The testing laboratory shall obtain and test two samples (at least 50 feet apart) from each 2.5 acre tract (hectare), or fraction thereof, in the sod field.

Certifications will be in effect for five years, at which time the sod field must be recertified.

If the sod placed on the project comes from more than one location, each location will require certification.

The Certificate of Compliance shall include:

- (1) Project number.
- (2) Name of Contractor and Subcontractor.
- (3) Location and size of sod field.
- (4) Sampling and testing dates.
- (5) Number of samples and tests.
- (6) Statement that the sod covered by this certification was grown in the area tested, and meets the 20 percent organic material limitation as determined by AASHTO T 267.

- (7) Name of independent testing laboratory.
- (8) Signature of a person who has the legal authority to bind the testing laboratory.

The cost of sampling and testing will not be paid for separately, but shall be included in the price bid for “Sodding.”

The Department reserves the right to sample and test the sod and the sod field at any time.

3. **Mulching.**

- a. **Hydro-Mulch.** Hydro-mulch shall contain no germination or growth-inhibiting factors and shall have the property of becoming evenly dispersed and suspended when agitated in water. Fiber mulch that is blended with recycled paper is not allowed.

When sprayed uniformly with hydraulic seeding equipment on the surface of the soil, the fibers shall form a blotter like ground cover, which will readily absorb water and allow infiltration to the underlying soil without restricting emergence of seedlings. Weight specification from suppliers, and for all applications, shall refer only to air dry weight of the fiber, considered to be 10 percent moisture.

The fiber mulch material shall be supplied in packages marked by the manufacturer to show the air dry weight content. Suppliers shall certify that laboratory and field testing of their product has been accomplished, and that it meets all specified requirements.

- b. **Grass Hay or Straw Mulch.** Grass or straw mulching material shall consist of native hay or straw from cereal grain and shall be seed free to prevent introduction of weeds as defined by the rules and regulations of the North Dakota Department of Agriculture. At least 50 percent of the mulch by weight shall be at least eight inches in length. The mulch shall be baled dry, in bales of approximately equal weight and shall be relatively dry when applied. Materials having characteristics making them unsuitable for the purpose intended will be rejected.

Mulch will be rejected for the following reasons:

- (1) Chopped or ground mulch; or
- (2) Mulch that is musty, moldy, rotted, or contains noxious weed or grass seed-bearing stalks; or
- (3) Mulch containing stones, dirt, roots, stumps, and other foreign material.

- c. **Bonded Fiber Matrix.** Bonded fiber matrix shall consist of a continuous layer of elongated fiber strands held together by a water resistant bonding agent. The bonded fiber matrix shall be uniformly applied and shall have no gaps between the product and the seeded soil. The product

shall be 100 percent biodegradable and composed of 90 percent wood fiber, 9 percent natural binder and 1 percent organic and mineral activators (all by weight). The treatment shall be installed with hydraulic seeding equipment.

C. Construction Requirements.

1. Seeding.

- a. **General.** Areas to be seeded shall be cleared of all material that is detrimental to seedbed preparation. The cleared areas shall be shaped to the Plan cross section, or to the cross section that best fits existing conditions.
 - (1) No seed shall be sown when the wind velocity exceeds 15 miles per hour. The Specification may be waived if the Contractor can prove to the satisfaction of the Engineer that the seeding method used allows for acceptable placement and retention of the seed in the soil.
 - (2) No seed shall be sown in standing water or frozen ground.
 - (3) All slopes shall be worked on the contour, or as directed by the Engineer.
 - (4) Ten pounds of oats per acre shall be seeded at the time of, or immediately preceding the seeding of Class I, II, and V grass mixtures. This is in addition to any Class IV Temporary seeding that may have been placed.
 - (5) If temporary seeding has been placed, the ground shall not be re-filled in order to place permanent seed.
- b. **Topsoil.** Topsoil shall consist of loose, friable, loamy topsoil free of excess acid, alkali, and objectionable amounts of sod. Topsoil shall have demonstrated the growth of healthy crops or grasses.
- c. **Types of Seedbed Preparation.**
 - (1) **General.** The seedbed shall be disked or field cultivated to a depth of approximately 3 inches. A harrow or cultipack (roller) shall be used so that the bed is firm and the seed can be placed at the proper depth (1/2 to 3/4 inch).

The seedbed shall be smooth and firm, and all lumps or clods exposed by the initial pass of tillage equipment shall be broken up to one inch in diameter or less. The seedbed on sites that are to be hydroseeded shall be left in a loose condition.

The type of seedbed preparation shall be as specified.
 - (2) **Type A.** This type of seeding shall be specified when stripping and stockpiling topsoil is not required.

The areas of exposed backslopes shall be covered as far as possible with the existing topsoil available during finish grading work without loading and transporting the topsoil.

When a grading project requires “rounding” of the top of the back-slopes, as much as possible of the “rounding” excavation shall be preserved to be spread over the exposed backslope in the final finishing operations before seeding.

- (3) **Type B.** This type of seeding involves the use of the topsoil salvaged and replaced during grading operations.
- (4) **Type C.** This seeding type requires placing approved topsoil from borrow areas to form a seedbed. The Contractor shall furnish the borrow areas if they are not shown on the Plans. Before topsoil is placed, the surfaces shall be shaped to the required section and disked, harrowed, scarified, or plowed to a depth of approximately 2 inches. The topsoil shall be placed in a uniform thickness to the depth shown on the Plans.

Topsoil borrow areas shall be finished according to Section 203.

- d. **Seasonal Limitations.** Class I, II, III, and V seed mixtures may be sown at any time during the year. If the Contractor chooses to seed with Class I, II, III, and V seed mixtures between June 15 and September 1, and the seed mixtures fail to achieve 100 percent coverage during the current or subsequent growing season, the Contractor shall reseed the failed areas at the Contractor’s expense. If the Contractor chooses not to seed with Class I, II, III or V seed mixtures between June 15 and September 1, then a Temporary Cover Crop shall be seeded.
- e. **Seeding Equipment Requirements.**

- (1) **Classes I, II, and V.** The specified seed or seed mixture shall be drilled in uniformly using a grass drill equipped with individually mounted adjustable spring loaded, double disk furrow openers fitted with depth bands and packer wheels. The drill furrow spacing shall not exceed 8 inches.

The depth control bands shall be of a size to provide final planting depth of 1/2 to 3/4 inch.

Packer wheels shall have adjustable spring tension and be mounted individually on each furrow opener or be mounted independently with a press wheel situated to follow directly behind each opener.

The seed box shall be equipped with a positive feed mechanism which accurately meters free flowing introduced (tame) grasses in a uniform manner and shall have agitators which prevent seed bridging. If chaffy native grasses (Sideoats Grama, Big Bluestem, Indian grass) are part of the specified seed mixture, the seed box shall be equipped with a positive feed picker-wheel mechanism with over-size teeth and augur style agitators which accurately meters the chaffy native grasses either in a mixture or separately in a uniform manner. The seed box shall have baffles or partitions that keep all seeds uniformly mixed during drilling.

In areas which have been seeded with a temporary cover crop, and the area has achieved vegetative coverage of 25 percent or greater of the pre-disturbed condition, the Contractor shall use a no-till method of application for the permanent seeding. The percentage of established vegetative coverage shall be as determined by the Engineer.

- (2) **Class III.** Seed-drilling equipment meeting the requirements for Classes I, II and V seed shall be used, when Class III (Hydro-Mulch) seeding is specified. If drilling equipment cannot physically access an area (in the opinion of the Engineer) or the slope to be seeded is steeper than 3:1 (H:V), hydraulic spraying equipment capable of mixing the specified seed in water for uniform distribution may be used. In all cases, the mulch shall be applied within 24 hours following seed application, using hydraulic spray equipment capable of mixing the specified mulch in water for uniform distribution.
- (3) **Class IV.** The equipment required to seed Class IV seed shall be a press drill equipped with an agitation system or other system that provides a uniform flow of seed at the required rate.
- (4) **Other Equipment.** Power sprayers, blowers, hydraulic applicators, or broadcasters may be used on slopes steeper than 3:1, areas too small to be seeded with a drill, and areas designated as wetlands. The seeding rate shall be at least 120 percent of the normal rate, and the seed shall be covered by operating a drag harrow and a light packer over the seeded area. All equipment shall be approved by the Engineer before it is used.

Areas will be visually inspected for uniformity of application. Areas which do not reveal adequate and uniform coverage shall be reseeded at the Contractor's expense.

- f. **Fertilizer.** The fertilizer shall be mixed with the Class III (Hydro-Mulch) mulch mixture, as the mixture is applied. If the seed is applied with hydraulic spraying equipment, the fertilizer may be mixed with the seed mixture. Otherwise, as stated above, the fertilizer may not be mixed with the seed (including under Class III application).
- g. **Reseeding and Repair.** Damage from wind or the Contractor's operation shall be repaired at the Contractor's expense. Repairs shall be made before final acceptance.
- h. **Temporary Care.** Areas seeded by the Hydro-Mulch method shall be wetted by daily sprinkling for the first five days, and then periodically for the next ten days to keep the soil moist for a depth of 3 inches. Hydroseeding completed after October 1 will not be provided Temporary Care. However, hydroseeding completed after October 1 will not be accepted until it shows evidence of established growth after May 15 of the following year.

2. Sodding.

- a. **Preparation of the Earth Bed.** The area to be sodded shall be shaped to the required cross section and contour, and shall be free of stones larger than 2 inches in diameter and other debris which interfere with the proper laying and growth of the sod.
- b. **Placing the Sod.** The sod on slopes shall be laid in horizontal strips beginning at the bottom of the slope and working upwards. In ditches the long length of the strip shall be placed at right angles to the flow.

Sod shall be laid so the joints formed by the abutting ends of strips are not continuous. Each strip shall be laid snugly against the strip previously laid. The ends of strips shall be placed to produce a broken line at the edges.

The outside edges of sodded areas (top, bottom, and sides) shall be turned into the soil and a layer of earth placed over the juncture. This earth shall be thoroughly compacted.

- c. **Staking the Sod.** On slopes 4:1 or steeper, the sod shall be anchored with stakes at least 6 inches in length spaced from 18 inches to 36 inches apart along the longitudinal axis of the sod strip. Stakes shall be driven within 1 inch of the sod surface.
- d. **Clean-Up.** After sod placement is complete, the surface shall be cleared of loose sod, excess soil, or other foreign material.
- e. **Fertilizer.** When fertilizer is specified, its analysis and application rate will be shown on the Plans.
- f. **Care and Maintenance.** The maintenance period of the sod will be four weeks from the time the sod placement is completed.

The Contractor shall be responsible for the watering and maintenance of the sod; and shall furnish and replace, without compensation, any sod that contains excess organic material, dies, is damaged, or washes out during the maintenance period. Replacement sod shall be installed under the same Specification requirements as those for the original sod, including the maintenance period.

The time between October 15 of any year and April 15 of the following year will not be a part of the required maintenance period. Sod placed at a time when the maintenance period extends past October 15 will not be accepted until it shows evidence of established growth after April 15 of the following year.

- g. **Acceptance.** At the end of the four-week maintenance period, the sod that is firmly established, well-rooted, growing, and green, will be accepted by the Engineer. Unacceptable sod shall be replaced as specified in Section 708.02 C.2.f, above.

3. **Hydro-Mulch.**

- a. **General.** The mulch shall be uniformly applied at a rate of one ton per acre and shall cover a minimum of 95 percent of the seedbed area. After

application, the mulch shall permit percolation of water to the underlying soil. All traffic, signs, structures, and other objects shall be protected from being marked or splattered by the material.

- b. **Tackifier.** The tackifier shall consist of water soluble natural proteins, vegetable gums, or guar gums blended with gelling and hardening agents; or a water soluble blend of hydrophilic polymers, viscosifiers, sticking aids and other gums. Guar gum based tackifiers shall consist of a minimum of 95 percent guar gum, by weight. The remaining 5 percent shall consist of dispersing and cross-link additives.

4. **Grass, Hay or Straw Mulch.**

- a. **General.** The mulch shall be placed within 24 hours after the seeding has been completed.

Mulching operations shall not be performed during periods of excessively high winds which would preclude the proper placing of the mulch.

Mulch containing excessive moisture which prevents uniform feeding through the machine shall not be used. Bales shall be broken up and loosened as they are fed into the blower to avoid placement of matted or unbroken lumps.

- b. **Equipment.** The mulch shall be machine blown and shall be uniformly distributed over the seeded areas. The machine shall be of a design that minimizes cutting or breaking of the mulching material.
- c. **Application.** The mulch shall be placed uniformly over the seeded areas at the rate of 2 tons per acre. Approximately 10 percent of the soil surface shall be visible through the mulch blanket before the mulch tiller (punching) operation.

Excessive cover which smothers seedlings of small seeded grasses shall be avoided.

- d. **Anchoring.** If not specified, one of the following two methods shall be used at the Contractor's option:

- (1) **Punching.** Immediately following application, mulch shall be punched into the soil using a mulch tiller consisting of a series of dull, flat disks with notched or cutout edges. The disks shall be approximately 20 inches in diameter, 1/4 inch thick, spaced approximately 8 inches apart, and shall be fitted with scrapers.

The tiller shall be operated on contour, except on slopes steeper than 3:1 where diagonal operations are required using a tractor with dual drive wheels or crawler treads on the tractor to minimize side slip and rutting to slopes.

Tiller members shall be ballasted as necessary to push the mulch into the soil 3 inches with ends of the mulch exposed above the soil surface.

- (2) **Tackifier.** The tackifier shall meet the requirements of Specification 708.02 C.3 b. The tackifier shall be applied by spraying simultaneously with the mulch or by spraying a surface application immediately following mulching. The application rate shall be between 175 and 275 pounds per acre. All traffic, signs, structures, and other objects shall be protected from being marked or splattered by the material.

- e. **Temporary Maintenance.** Repairs shall be made as necessary before final acceptance as directed by the Engineer.

All areas that have been properly anchored and accepted by the Engineer that have to be remulched because of wind or water erosion shall be at the Department's expense. All areas damaged by traffic or the construction operations shall be repaired at the Contractor's expense.

5. **Bonded Fiber Matrix.** Rate of application shall be 3,900 pounds per acre (4,375 kg/hectare) and the mix shall consist of 50 pounds bonded fiber matrix to 125 gallons water (50 kg bonded fiber matrix to one cubic meter water) unless otherwise specified by the Engineer. Bonded fiber matrix shall be placed on a given area as soon as possible, or within 24 hours after seeding.

D. Method of Measurement.

1. **Seeding.** Seeding or any authorized reseeding on seedbed preparation will be measured by the Acre or Mile along the roadway centerline, complete and in place.
2. **Temporary Cover Crop.** Hydro-Mulch and Temporary Cover Crop seeding will be measured by the Acre complete and in place.
3. **Topsoil for Type B Seedbed.** Topsoil for Type B seedbed preparation will not be measured for payment as part of seeding operations, but will be measured and paid for as part of grading operations according to Section 203.
4. **Topsoil for Type C Seedbed.** Topsoil for Type C seedbed preparation will be measured by the cubic yard in its original position in the borrow area or in the hauling unit.
5. **Fertilizer.** Fertilizer will be measured by the Hundred Weight (CWT), used as authorized and required. No measurement will be made when fertilizer is not a pay item and no payment will be made.
6. **Sodding.** Sod will be measured by the Square Yard, complete, in place, and accepted by the Engineer. Water will not be measured for payment but shall be included in the bid item "Sodding."
7. **Mulching.** Mulching or any authorized remulching will be measured by the Acre complete and in place. Anchoring of the mulch shall be included in the bid item "Mulching."

E. Basis of Payment.

Should the area of seeding, sodding, or mulching, which is part of an approved subcontract, decrease by more than 25 percent, the Contractor may submit a request for an adjustment of the Contract Unit Price. The adjustment in unit price will only be considered if it justifies an increase in the pro rated share of the fixed costs chargeable to the item because of the decreased quantity. The total payment for the final quantity shall not exceed 75 percent of the original contract quantity at the Contract Unit Price.

Should the quantity of seeding, sodding, or mulching which is part of an approved subcontract increase by more than 25 percent from the original contract quantity either party to the contract may submit a request for an adjustment of the Contract Unit Price for the quantity in excess of 125 percent of the original contract quantity.

The Contractor shall provide a notice of intent to request an adjustment in the Contract Unit Price as soon as the Contractor is aware of overruns or underruns. All adjustments in unit price will be determined according to Section 104.03 B.2. if requested by the Department, the Contractor shall furnish the bid documents used to calculate the Contract Unit Price. Failure to submit the bid documents will result in the Contractor waiving all rights to an adjustment in the Contract Unit Price.

Payment will be made at the Contract Unit Prices for the following:

Pay Item	Pay Unit
Seeding: Type ____ Class ____	Acre or Mile
Temporary Cover Crop	Acre
Topsoil for Type C Seeding	Cubic Yard
Fertilizer	CWT
Sodding	Square Yard
Mulching	Acre

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

708.03 EROSION CONTROL BLANKET AND TURF REINFORCEMENT MAT

A. **Description.** This work consists of placing an erosion control blanket or turf reinforcement mat on a prepared slope or channel.

B. **Materials.**

Material shall meet the requirements of the type specified on the Plans, as detailed in Section 856 of the Standard Specifications.

Item	Section
Erosion Control Blanket (ECB)	
ECB Type 1	856.01
ECB Type 2	856.01
ECB Type 3	856.01
ECB Type 4	856.01
Turf Reinforcement Mat (TRM)	
TRM Type 1	856.02
TRM Type 2	856.02
Staples	856.03

C. Construction Requirements.

1. **All the Erosion Control Blankets and Turf Reinforcement Mat Type 1.** The area to be covered shall be properly prepared and seeded before the blanket is applied. All rocks or clods over 1-1/2 inches in diameter, and all sticks and other foreign material shall be removed.
2. **Turf Reinforcement Mat Type 2.** The area to be covered shall be properly prepared before the mat is applied. Some of these mats require the mat to be soil-filled first then seed and fertilizer is placed on top of the soil-filled mat. The mat shall provide sufficient thickness, strength, and void space to permit soil filling and/or retention and promote the development of vegetation within the matrix. Mats shall be filled with topsoil, topsoil blends, or compost. To prevent temporary loss of topsoil media and seed after placement, apply hydro mulch or erosion control blanket. All rocks or clods over 1-1/2 inches in diameter, and all sticks and other foreign material shall be removed.

If netting is specified for one side only, the blanket shall be placed with the netting on top and the fibers in contact with the soil.

In ditches, blankets and mats shall be applied from the top of the slope or gradient (ditch grade) and unrolled in the same direction as the flow of water. If more than one blanket or mat is used, the first blanket or mat shall be centered in the low point of the ditch or channel throughout the length of treatment. The remaining blankets or mats shall be placed equally on each side of the first.

On roadway fill embankments less than 10 feet high, blankets may be unrolled either horizontally or vertically to the slope.

Do not puncture blankets or mats to stake erosion control devices on top of the blankets or mats.

3. **Repair of Soil Retention Blankets and Mats.** Blankets and mats damaged by construction operations shall be repaired by and at the Contractor's expense. The area shall be restored to the proper contour, seeded and fertilized, and recovered with the same type of soil retention blanket that was damaged.

- D. Method of Measurement.** Erosion control blanket and reinforcement mat shall be measured by the actual actual surface area covered to the nearest square yard. No allowance will be made for overlaps and buried blankets or mats. Staples or

any other material required to place the material, as specified, will not be measured for payment but shall be included in the price for the pay item. Material that is, damaged, wasted, or not properly placed will not be measured for payment.

E. Basis of Payment.

Payment will be made at Contract Unit Prices for the following:

Pay Item	Pay Unit
ECB Type 1	Square Yard
ECB Type 2	Square Yard
ECB Type 3	Square Yard
ECB Type 3	Square Yard
TRM Type 1	Square Yard
TRM Type 2	Square Yard

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

708.04 RIPRAP AND AGGREGATE CUSHION.

A. Description. This work consists of furnishing or salvaging, and placing stone on slopes, channelways, or other areas. Any excavation and shaping necessary to place this material shall also be included in the price bid for these items.

B. Materials.

1. **Wire Mesh.** Wire Mesh shall meet Section 836.03 C.
2. **Grout.** Grout shall be composed of one part Portland Cement and two parts sand by volume. All materials shall be approved before being used.
3. **Riprap.** Riprap shall consist of sound, durable field stone or quarry stone.

a. **Gradation.**

Riprap shall meet the following gradations:

Size (Inches)	Percent Smaller
28*	80-100
22*	30-80
16	20-50
10	0-5

*The maximum size of stone permitted for riprap installation shall not exceed the specified thickness of the riprap blanket by more than 6 inches. Stone of this excess size may be placed providing it does not exceed 10 percent of the total stone and can be blended satisfactorily into the riprap.

- b. **Field Stone.** Acceptable field stone shall be any field stone not made of sandstone, shale, or soft limestone; or not easily abraded or crushed. The stone shall not contain cracks or flaws that would cause splitting or breakup during loading, hauling, and placing.
- c. **Quarry Stone.** Quarry stone shall be obtained from an undisturbed deposit of rock that, if properly processed, would meet the requirements of

concrete coarse aggregate for soundness and abrasion. Local deposits of sandstones or limestones and similar stone of sedimentary origin shall not be used as riprap stone.

4. **Aggregate Cushion.** Aggregate Cushion shall meet the requirements of Section 816 for Class 8.

C. Construction Requirements.

1. **General.** The slope shall be excavated, shaped, and completed to the required cross section and elevation.

The laying of stone on sloped areas shall begin at the toe of the slope, and a trench shall be dug to the dimensions specified. When no dimensions are shown, a trench at least one foot deep shall be dug, and the largest stones shall be placed in the trench. The riprap shall be thoroughly compacted as the construction progresses and the finished surface of the riprap shall present an even, tight surface. Gaps shall be filled with smaller stones.

2. **Aggregate Cushion.** Aggregate cushion shall be spread over the specified area before placing the riprap.
3. **Wire Mesh Riprap.** When wire mesh riprap is specified, the riprap stone shall have wire mesh above and below the layer of rock and around the ends and sides.

Strips of wire mesh shall be laid parallel to the length or direction of the riprap. Adjoining strips and ends of strips shall be tied every 18 inches with wire at all abutting wire sections.

End splices of a strip of wire mesh shall be staggered at least 10 feet with the end splices in the adjacent strip of wire mesh. No length of wire mesh less than 10 feet long shall be used.

The lower layer of wire mesh shall be tied to the upper layer of mesh with wire ties spaced not over 2 feet center to center each way.

4. **Loose Rock Riprap.** When loose rock riprap is specified, the rock may be placed by mechanical means or by hand. Damage to the prepared slope or to structural components shall be repaired at the Contractor's expense.

Riprap stone shall be distributed evenly over the riprap area without pockets of segregated sizes of stone. The stone may have to be rearranged by manual or mechanical means if placement methods result in pockets of segregated size of stone.

The finished surface of the riprap area shall present an even distribution of stone sizes over the entire riprap area with no one area of any size deviating from the Plan slope and grade by 6 inches.

D. Method of Measurement.

1. **Wire Mesh Riprap.** Wire Mesh Riprap will be measured by the Square Yard in place. The area will be computed on the basis of actual surface dimensions as staked and the specified thickness.

2. **Loose Rock Riprap.** Loose Rock Riprap will be measured in the hauling vehicle by either the Cubic Yard or by the Ton.

Loose Rock Riprap not placed as specified and not accepted by the Engineer will be deducted from the total material measured and will not be paid for.

The Engineer will deduct for any partial load delivered or any load containing contaminants. The deduction will be solely based upon the judgment of the Engineer.

Stone exceeding the maximum allowable size by more than 10 percent in any dimension will be rejected and not measured for payment. The Contractor shall dispose of such oversize stone.

Aggregate Cushion will be measured by the Ton or Cubic Yard as shown on the Plans. The volume will be computed on the basis of actual surface dimensions as staked and the specified thickness.

E. Basis of Payment.

Payment will be made at Contract Unit Prices for the following:

Pay Item	Pay Unit
Wire Mesh Riprap	Square Yard
Loose Rock Riprap	Ton or Cubic Yard
Aggregate Cushion	Ton or Cubic Yard

This payment will be full compensation for all labor, equipment, materials, excavation, and shaping necessary to complete the work.

708.05 FABRIC FORMED SLOPE PROTECTION.

- A. **Description.** This work shall consist of furnishing and placing an approved grout-injected fabric-formed slope protection.

B. Materials.

Material shall meet the following:

Item	Section
Cement	804.01
Concrete Admixtures	808
Water	812
Aggregate	816
Fly Ash	820
Fabric	856.06

Aggregate grading shall be consistent and shall be well graded from the maximum size which can be conveniently handled with available pumping equipment.

Grout shall consist of a mixture of Portland Cement, fine aggregate, and water proportioned to provide a pumpable slurry. The mix shall obtain a compressive strength of 2,500 psi at 28 days. The air content of the mixed grout shall be in the range of 5 to 8 percent.

- C. **Construction Requirements.** Only approved mixing and pumping equipment shall be used in preparation and handling of grout. Oil or other rust inhibitors shall be removed from mixing drums, stirring mechanisms, and other portions of equipment in contact with grout before the mixers are used. Pumping equipment shall have a variable flow rate to provide enough pressure for pumping without breaking the fabric.

All material shall be accurately measured by volume or weight as it is fed into the mixer. The quantity of water shall produce a grout having a pumpable consistency. Mixing time shall be at least one minute. If agitated continuously, the grout may be held in the mixer or agitator for 2-1/2 hours or less in temperatures below 70°F, and for two hours or less at higher temperatures. If a lapse in pumping operation occurs, the grout shall be recirculated through the pump, or the mixer drum, or the agitator and pump.

Before grout injection, the fabric must be positioned at its design location. Each panel shall be continuous or monolithic for its full width, and all seams must be vertical. Grout shall be introduced into the space between the layers of fabric and shall be injected to avoid excessive pressure on the fabric envelope. Adjacent fabric panels shall be joined before grout injection by field sewing with nylon thread. Where adjacent panels cannot be joined in this manner, or where specified, adjacent panels shall be lapped a minimum of 2 feet. In no case will simple butt joints be permitted.

In the event that blisters or blowouts occur during grout injection, the section affected shall be repaired or replaced to match adjacent surfaces.

Sequence of injected grout must follow the manufacturer's recommendations.

The fabric-forming material shall not be placed or filled on frozen ground. The injected grout shall be protected from freezing for at least four days after placement. No curing of the completed mat will be required.

- D. **Method of Measurement.** Fabric-Formed Slope Protection, including embedded portions, will be measured in Square Yard, complete and in place, based on the dimensions shown on the Plans.
- E. **Basis of Payment.**

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Fabric-Formed Slope Protection	Square Yard

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

708.06 CONCRETE SLOPE PROTECTION.

- A. **Description.** This work consists of placing a cast-in-place concrete slope protection.
- B. **Materials.**

Materials shall meet the following:

Item	Section
Cement	804.01
Air-Entraining Admixture	808
Curing Materials	810
Water	812
Aggregate	816
Fly Ash	820
Preformed Expansion Joint Filler	826.02
Joint Sealer	826.02 A.4
Reinforcing Steel	836
Welded Steel Wire Fabric	836.03 C

C. Construction Requirements.

1. **Preparation of Subgrade.** The subgrade, for placing concrete slope protection, shall be free of rubbish and vegetation. All loose material shall be thoroughly compacted. The Contractor shall excavate or backfill as required to obtain the Plan cross section or lines and grades established in the field.

All dry surfaces shall be wetted before placement of concrete. Concrete shall not be placed on any surface which is spongy or where free water exists.

The areas adjacent to the slope protection shall be left in a smooth, uniform condition.

2. **Placing Reinforcement.** The reinforcement shall be free from dirt, detrimental scale, paint, oil, or other foreign substance.

Welded steel wire fabric and bar reinforcement shall be placed and secured so its final position in the hardened concrete meets the specified requirements.

3. **Composition of Concrete.** Concrete shall be Class AE-3 and shall meet Section 802.

4. **Placing Concrete.** Weather limitations shall be as specified in Section 602.

The concrete shall be placed and consolidated by methods that prevent segregation or sagging.

Whenever placement of concrete is stopped for the day or otherwise interrupted for more than 30 minutes, a construction joint shall be placed at the end of a panel.

5. **Relief Joints.** Joints shall consist of perpendicular grooves in the surface of the plastic concrete. The grooves shall meet the dimensions and locations shown on the Plans. They shall be maintained to the required shape during any subsequent finishing operations until the concrete has hardened.

The joints may be sealed as soon as the concrete becomes stiff enough to prevent distortion to the groove or damage to the concrete. The grooves shall be cleaned and devoid of foreign substance or free water when the joint sealer is

applied. The sealer shall be applied with a caulking gun or other approved device.

- 6. **Finishing Concrete.** The final finish shall be obtained with a wood float. The surface shall be checked for irregularities with a 10-foot straightedge. The allowable tolerance for depressions or high spots in any 10 feet shall be 3/4 inch.
 - 7. **Curing Concrete.** After final finishing, the concrete shall be cured according to Section 550.04, except that the minimum curing period shall be five days.
 - 8. **Tests on Concrete.** The concrete will be tested according to Section 802.
- D. **Method of Measurement.** Concrete Slope Protection will be measured parallel to the surface by the Square Yard, complete and in place, based on the dimensions shown on the Plans.

The cost of all earthwork shall be include in the bid item "Slope Protection."

E. **Basis of Payment.**

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Concrete Slope Protection	Square Yard

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

708.07 SILT FENCE.

- A. **Description.** This work shall consist of furnishing, installing, maintaining, and removing a geotextile barrier-fence designed to remove suspended particles from storm water runoff. The quantities of silt fence shown on the plans may be increased or decreased as directed by the Engineer based on weather, Contractor operations or actual site conditions that occur during construction of the project. Such variations in quantity will not be considered as a change in character of work. A Pre-Fabricated silt fence will not be allowed.

B. **Materials.**

- 1. **Posts.** Either wood or steel posts may be used. Wood posts shall be treated (Penta or Green Treated) and shall be a minimum of 6 feet long with minimum dimensions of 2 inches diameter for round posts or 1-1/2 inches by 1-1/2 inches for rectangular posts. Steel posts shall be a minimum of 5 feet long, weigh a minimum of 1.3 pounds/foot and have projections to aid in fastening the wire or fabric. Steel posts shall have a metal plate welded near the bottom such that when the post is driven to the proper depth, the plate will be below the ground level for added stability.
- 2. **Woven Wire.** When backing for a filter fabric silt fence is required, a steel wire fence fabric shall be used. A woven wire fence shall conform to ASTM

A 116, Class 1 zinc coating for wire. The woven wire support fence shall be at least 32 inches high and a maximum opening size of 6 inches by 6 inches. The wire shall be a minimum of 14 gage grade 60.

3. **Filter Fabric.** Silt fence fabric shall conform to AASHTO M 288 silt fence Specification. Filter fabric shall be composed of fibers consisting of long chain synthetic polymers composed of at least 95 percent by weight of polyolefins, polyesters or polyamides. The fibers shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other. The filter fabric shall be free of any treatment or coating which might adversely alter its physical properties after installation. The fabric shall be free of defects or flaws that significantly affect its physical and/or filtering properties. The fabric shall have a minimum width of 36 inches. The filter fabric shall be furnished with suitable wrapping for protection against moisture and extended ultraviolet exposure prior to placement.

The filter fabric shall meet the minimum physical requirements contained in Table 1. Unless otherwise indicated, numerical values represent the minimum average roll value. The required numerical value for the AOS is the maximum allowable in SI Units and the minimum allowable in U.S. Standard Sieve Numbers.

Table 1

Property	Test Method	Supported *	Unsupported
Grab Tensile Strength (lbs)	ASTM D 4632		
Machine		90	123
Cross Machine		90	101
Permittivity (sec ⁻¹)	ASTM D 4491	0.05	0.05
Water Flow Rate (gpm / ft ²)	ASTM D 4491	4.43	4.43
AOS (US Sieve #) mm Sieve #	ASTM D 4751	0.600 #30	0.600 #30
UV Resistance (%)	ASTM D 4355	70%@500 hrs	70%@500 hrs

*Silt fence support shall consist of 14 gage steel wire with a mesh maximum spacing of 6 inches by 6 inches.

C. Construction Requirements.

In addition to the Standard Drawing shown in the Plans, the following will apply:

1. **Installation.** The geotextile at the bottom of the fence shall be buried in a “J” configuration to a minimum depth of 6 inches in a trench so that no flow can pass under the silt fence. Wire support fence if used shall also be buried a minimum of 2 inches. The trench on the upstream side of the silt fence shall be backfilled and the soil compacted over the geotextile.

Silt fence fabrics shall be spliced together only at support posts with a minimum of 18 inches of overlap and in such manner to prevent silt from passing between the two ends. At the time of installation, the fabric or fence will be rejected if it has any defects, deterioration, or other damage incurred during manufacture, transportation, storage, or installation.

Posts shall be spaced 4 feet apart and driven or placed a minimum of 20 inches into the ground. Depth shall be increased to 24 inches if fence is placed on a

slope 3:1 or greater. Geotextiles shall be attached to posts by staples, wire, nails, or in accordance with the manufacturer's recommendations. Wire staples shall be a No. 17 gauge minimum and shall have a minimum 0.75 in. wide crown and 0.5 in. long legs. Staples shall be evenly placed with at least 4 per post. Nails shall be a minimum of 14 gauge, 1 inch long, with 0.75 button heads. Nails shall be evenly spaced with at least four per post.

Silt fences should be continuous and transverse to the flow. The silt fence should follow the contours of the site as closely as possible. The fence shall also be placed such that the water cannot flow around the end of the fence.

2. **Maintenance.** Sediment deposits shall be removed when the deposit reaches half of the height of the silt fence at the lowest area or when directed by the Engineer. Silt fence shall be inspected by the Contractor immediately after each rainfall and at least daily during prolonged rainfall. Any deficiencies shall be immediately corrected. Filter fabric shall be removed and replaced whenever it has deteriorated to such extent that it reduces the effectiveness of the silt fence. In addition, the Contractor shall make daily review of the location of silt fences in areas where construction activities have changed the natural contour and drainage runoff to ensure that the silt fences are properly located for effectiveness. Where deficiencies exist, additional silt fences may be installed as directed by the Engineer.

If a silt fence, or portion of a fence, is located in an area where removing the sediment is not possible, then a second silt fence may be installed at the discretion of the Engineer. In this case, the silt fences or portions involved, will be measured and paid for at the unit price for silt fence.

Silt fence shall remain in place until the vegetative coverage is restored to seventy percent of preexisting vegetation. Fence materials that are removed will be disposed of by the Contractor. Upon removal, the Contractor shall dress the area to give a pleasing appearance, and vegetate all bare areas in accordance with the contract requirements. If the new reshaped area still poses an erosion threat, the Engineer may require the Contractor to erect a new silt fence. If vegetative coverage is not restored to 70 percent of preexisting vegetation prior to project acceptance, the silt fence will remain in place and will be removed by the Department.

- D. **Method of Measurement.** Silt fence will be measured to the nearest linear foot of fence actually installed in accordance with the Plans or as required by the Engineer. The measurement for payment excludes the fabric or fence material used for overlapping as well as fabric used for seam overlaps.

- E. **Basis of Payment.**

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Silt Fence Supported	Linear Foot Installed
Silt Fence Unsupported	Linear Foot Installed

This payment will be full compensation for all materials, equipment and labor to install and remove the silt fence.

Cleaning of the sediment deposits shall be paid at the price listed in the “Price Schedule PS-1.”

708.08 FIBER ROLLS.

- A. **Description.** This work shall consist of furnishing, installing, maintaining and removing fiber rolls for erosion control.
- B. **Materials.** Fiber rolls shall consist of hay or straw free of noxious weeds, or wood excelsior that has been compressed and stuffed into degradable netting. Dimensions of the 6-inch roll shall be approximately 6 inches nominal in diameter, dimensions of the 12-inch roll shall be approximately 12 inches nominal in diameter, and dimensions of the 20-inch roll shall be approximately 20 inches nominal in diameter.
- C. **Construction Requirements.** In addition to the Standard Drawing shown in the Plans, the following will apply:
1. **Installation.** Each fiber roll shall be overlapped 1 foot minimum and tied tightly together, to prevent flow between the fiber roll ends. Fiber rolls shall be trenched and staked according to manufacturer’s specifications. Trenching is not required for “Fiber Rolls 20 inch.” Use 6-inch rolls around drop inlets and on contours for sheet flow down backslopes and foreslopes. Use 12-inch and 20-inch rolls in the ditch bottom, pipe inlets, and at the edge of the right of way.
 2. **Maintenance.** Sediment deposits shall be removed when the deposit reaches half the height of the fiber roll or when directed by the Engineer. Fiber rolls shall be inspected by the Contractor immediately after each rainfall and at least daily during a prolonged rainfall. Any deficiencies shall be immediately corrected. Fiber rolls shall be removed and replaced whenever the fiber rolls deteriorate to such extent that the effectiveness of the fiber roll is reduced. The Contractor shall make daily review of the location of fiber rolls in areas where construction activities have changed the natural contour and drainage runoff to ensure that the fiber rolls are properly located for effectiveness. Where deficiencies exist, additional fiber rolls may be installed as directed by the Engineer.

If a fiber roll, or portion of a fiber roll, is located in an area where removing the sediment is not possible, then a second fiber roll may be installed at the discretion of the Engineer.

Fiber rolls shall remain in place until the vegetative coverage is restored to 70 percent of the preexisting vegetation. Fiber roll materials that are removed will be disposed of by the Contractor. Upon removal, the Contractor shall dress the area to give a pleasing appearance, and vegetate all bare areas in accordance with the contract requirements. If the new reshaped area still poses an erosion threat, the Engineer may require the Contractor to install fiber rolls. If vegetative coverage is not restored to 70 percent of preexisting vegetation prior to project acceptance, the fiber roll will remain in place and will be removed by the Department.

- D. **Method of Measurement.** Fiber rolls will be measured to the nearest linear foot, excluding overlaps, installed in accordance with the Plans or as required by the Engineer.
- E. **Basis of Payment.** Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Fiber Rolls __ IN	Linear Foot Installed

This payment will be full compensation for all materials, equipment and labor to furnish, install, maintain and remove the fiber rolls.

Cleaning of the sediment deposits shall be paid at the price listed in the “Price Schedule PS-1.”

708.09 FLOTATION SILT CURTAIN

- A. **Description.** This work consists of furnishing, installing, maintaining, and removing flotation silt curtain as a temporary erosion control measure.
- B. **Materials.** Floating Silt Curtain should meet the following materials properties:

Materials and Properties	Still Water	Moving Water or Work Area
Curtain Fabric	Impermeable vinyl-nylon laminate	Impermeable vinyl-coated nylon
Mass/sq. yd.	18 oz.	22 oz.
Grab Tensile Strength	300 lbs.	500 lbs.
Depth of Curtain	2 - 10 feet	
Flotation	6-inch dia. Marine quality expanded polystyrene	8” dia. Marine quality expanded polystyrene
Net Buoyancy per foot	13 lbs.	20 lbs.
Top Load Carrying Components	Fabric only	Fabric + 5/16 inch galvanized steel cable 9,800 lb. min break strength
Ballast (min.)	1/4 inch galvanized chain	5/16 inch galvanized chain
Connections Between Sections	Laced grommets	Aluminum collar reinforced quick disconnects

- C. **Construction Requirements.**
 - 1. **Installation.** In all cases anchor lines shall be attached to the flotation device, not to the bottom of the silt curtain.
 - a. **Still Water.** In still water lakes or ponds both ends of the curtain shall be secured on land using the anchor points and using anchor buoys if bottom anchors are employed. The curtain shall be towed out, in the furled condition, and attached to these stakes or anchor points. Any additional stakes or anchors required to maintain the desired location of the curtain

shall be set and these anchor points made fast to the curtain. The furling lines shall then be released to let the curtain skirt drop.

- b. **Moving Water.** In flowing water all curtain anchor points shall be set. Anchor points must be of sufficient holding power to retain the curtain under the existing current conditions prior to putting the furled curtain into the water. Anchor buoys shall be employed on all anchors to prevent the current from submerging the curtain at the anchor points. When the anchors are secure, the furled curtain shall be secured to the upstream anchor point and then sequentially attached to each next downstream anchor point until the entire curtain is in position. At this point, and before unfurling, the position of the curtain shall be assessed and any necessary adjustments made to the anchors. Once the curtain is in the desired location, the furling lines shall be released to allow the skirt to drop.

Flotation silt curtain shall not be installed across the entire width of a flowing channel.

- c. **Work Area.** When a work area extends into a maximum of 1/4 of a flowing waterway's width the area shall be bounded on the downstream side by a flotation silt curtain. The curtain shall extend outward from the shore at an angle, not more than 1/3 of the waterway's width and shall be anchored with a minimum of 40 lbs. at a maximum of 100-foot intervals.
2. **Maintenance.** Flotation curtains that have difficulty staying afloat, come loose from anchor points or buoys, or are otherwise failing to perform as designed shall be repaired or replaced at the Engineer's discretion before work in areas affecting the water body is allowed to continue.
3. **Removal.** Removal can take place after work areas are removed and/or final grading on above slopes is completed. Silt fence or similar sediment control devices shall be installed at the toe of slopes before the flotation curtain is removed, unless the slope is covered with riprap.

Flotation curtain shall be cleaned out before removal.

- D. **Method of Measurement.** Flotation Silt Curtain will be measured to the nearest linear foot. Flotation Silt Curtain will be paid for at the contract unit price per linear foot. Payment will be full compensation for materials, labor and equipment necessary to provide, install, maintain, and remove the flotation silt curtain.
- E. **Basis of Payment.** Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Flotation Silt Curtain	Linear Foot Installed

This payment will be full compensation for all materials, equipment and labor to furnish, install, maintain and remove the flotation silt curtain.

708.10 STABILIZED CONSTRUCTION ACCESS

- A. **Description.** This work consists of protecting paved roadways adjacent to borrow areas or areas where excess excavation is to be removed or placed, and the installa-

tion, maintenance and removal of stabilized construction accesses at those locations.

B. Materials.

1. **Aggregate.** Aggregate material for the Stabilized Construction Access will meet the following requirements:

Sieve Size	Percent Passing
3 inch	100
1 inch	0

The aggregate shall have 75 percent fractured faces

2. **Geotextile Fabric.** Geotextile fabric shall meet the requirements for R1 Fabric according to Section 858.

- C. Construction Requirements.** If an access is constructed that restricts flow through a ditch, the contractor will determine the correct length and size culvert to meet the existing conditions. If an access is placed where topsoil exists, the topsoil shall be stripped before the access is constructed and replaced and reseeded after removal.

A Stabilized Construction Access may not be placed in an area designated as a wetland.

- D. Maintenance.** The Contractor shall maintain all stabilized construction accesses for the duration of their use. The Contractor shall sweep clean all construction-related debris tracked onto the existing paved roadways adjacent to these locations at the end of each working day unless otherwise approved by the engineer. The limits of the maintenance shall be the entire length of the haul road to and from the destination.

Additional rock shall be added as needed.

- E. Method of Measurement.** Stabilized Construction Accesses will be measured by the number of individual access points installed as part of the construction contract, without regard to size or location. The pay item shall be considered full payment for any topsoil or seeding requirements where the access has been constructed.

- F. Basis of Payment.** Payment will be made at the Contract Unit Price for the following.

Pay Item	Pay Unit
Stabilized Construction Access	Each

This payment will be full compensation for all equipment, labor and materials (including fabric, aggregate, culvert, etc) to construct, maintain and remove Stabilized Construction Accesses.

SECTION 709 GEOTEXTILE FABRICS

709.01 DESCRIPTION.

This work consists of furnishing and installing a geotextile fabric.

709.02 MATERIALS.

The geotextile fabric specified shall meet the requirements of Section 858.

709.03 CONSTRUCTION REQUIREMENTS.

A. General.

The surface receiving the fabric shall be smooth and free of stones, sticks, and other debris or irregularities that might puncture the fabric. The fabric shall be placed free of wrinkles and shall be protected at all times during construction. Construction equipment shall not be operated on the fabric.

The fabric shall be overlapped a minimum of 18 inches at all splices or joints. In lieu of joint overlapping, multiple fabric pieces may be sewed if the seam strength meets the seam strength requirements listed in Section 858.01 A. A 401 stitch conforming to Federal Standard No. 75 1a shall be used for all seams. Overlapping "J" seams are required for field seams. All seams shall be sewn with two parallel stitch lines spaced approximately 1/4 inch apart. The outside stitch shall be placed approximately 1 inch from the edge of the fabric. The thread shall be of a material that meets the requirements specified for the fabric.

The geotextile fabric and a certification of compliance shall be delivered to the project at least 21 days prior to its incorporation into the work. Fabric shall be approved by the Engineer before installation.

If a fabric is tested and fails, any retests will be at the cost of the Contractor, unless the results of the retest show the fabric passes.

If the Engineer allows installation and the fabric fails to meet the specified requirements a minimum price adjustment of 20 percent will be assessed to the bid price for any fabric installed. Actual penalties will be determined by the Engineer, based on projected performance of fabric. If the failing fabric jeopardizes the integrity of the project, the fabric will be removed and replaced at the Contractor's expense.

If sewn seams are going to be used, the Contractor shall also 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.

To facilitate inspection and repair, the geotextile should be placed with all seams up.

Sheepsfoot rollers shall not be used for compaction until a minimum of 3 feet of fill is covering the geotextile.

Fabric shall not be left uncovered for longer than five days. Fabric that is not covered within five days shall be removed and replaced at the Contractor's expense.

The fabric shall be secured using the manufacturer's recommended methods to hold the fabric in place during the construction activities.

Before placing the material on the fabric, the Contractor shall demonstrate that the placement methods will not damage the fabric. The Engineer may order the removal of at least 4 square yards of material to inspect for fabric damage. Tears or rips in the fabric shall be patched with fabric lapped a minimum of 36 inches around the rip.

B. Geotextile Separation Fabric.

When placing the fabric, the geotextile shall be unrolled in line with the placement of the new aggregate. The fabric shall not be dragged across the subgrade. Fabric widths shall be used so overlaps of parallel rolls occur at the centerline and at the shoulders. Overlaps shall not be placed along the wheel path locations. The 18-inch overlap at the end of the roll shall be in the direction of the aggregate placement so the previous roll laps over the subsequent roll.

The first lift above the separation fabric shall have a minimum depth of 9 inches before compaction. When the first layer of aggregate is placed, construction equipment shall be limited in size and weight so rutting in the initial lift is less than 3 inches. If rutting does occur additional aggregate shall be placed to fill the ruts. The ruts shall not be bladed out. Construction equipment shall not be turned on the first layer of aggregate placed on the fabric.

Geotextile fabric for wrapping the joints of pre-cast box culverts shall meet the Specifications of Section 858.01 A., separation fabric Type S2.

C. Filter Fabric (Underdrains).

After the fabric has been secured in place, the aggregate shall be deposited by methods that will not tear, puncture, or reposition the fabric. The aggregate shall not be dropped on the fabric from a height greater than 3 feet.

The underdrain granular fill shall meet the gradation requirements of Section 816.02 A.1.

D. Filter Fabric (Riprap).

If more than one length or width of fabric is necessary, all joints shall be overlapped or sewn as required in Section 709.03 A.

When the fabric is used for scour or stream bank protection it shall be placed loosely and be unrolled in the direction of the anticipated water flow. If the fabric is overlapped, the overlap shall be placed so the upstream strip laps over the down-

stream strip. The laps along the length of the fabric, parallel to the waters edge, shall be placed so the upper strip overlaps the lower strip. All overlaps shall be pinned or stapled at 3-foot intervals.

Fabric used to protect against wave action may be unrolled parallel or perpendicular to the waters edge. The joints or seams of all fabric placed parallel to the waters edge shall be sewn.

The riprap shall be deposited and spread over the fabric by methods that do not tear, puncture, or reposition the fabric. Riprap stones less than 250 pounds shall not be dropped on the fabric from a height greater than 3 feet. Stones greater than 250 pounds shall be placed with no free-fall. Contouring of the stones shall be achieved during their initial placement. The stones shall not be rolled along the surface. Placement of the stone cover shall begin at the base of the slope and at the center of the geotextile covered zone.

E. Geotextile Reinforcement Fabric.

Reinforcement fabric that is placed under roadway shall be unrolled parallel to the centerline of the road and shall be placed as shown in the Plans. The fabric shall be placed such that it is taut and pinned, using a minimum of 6-inch pins. The pins shall be placed at a nominal 15-foot spacing along all edges and at all corners, prior to placing any material on the fabric.

The fabric shall be overlapped a minimum of 30 inches at all splices or joints. The 30-inch overlap at the end of the roll shall be in the direction of the aggregate placement so the previous roll laps over the subsequent roll.

The first lift above the reinforcement fabric shall have a minimum lift of 12 inches before compaction.

Small dozer equipment or front-end loaders with low ground pressures shall be used to spread the cover material.

F. Shipping and Storage.

Geotextile labelling and identification shall comply to ASTM D 4873-95. If a label is removed during sampling or other reasons, the roll must be relabeled.

Packaging, handling, and storage of geosynthetics shall conform to ASTM D 4873-95 and the following requirements. Each Geotextile roll shall be wrapped with a waterproof cover or membrane for protection during shipping and storage. Geotextiles shall not be exposed to ultraviolet light for more than 14 days and shall be elevated off the ground during storage.

709.04 METHOD OF MEASUREMENT.

- A. Geotextile Separation Fabric.** The fabric used for separation and for riprap shall be measured by the actual surface area covered to the nearest Square Yard. No allowance will be made for overlaps, drainage trenches, or cutoff trenches unless otherwise shown on the Plans.
- B. Filter Fabric (Underdrains).** The fabric used for underdrains will be measured by the Square Yard, complete and in place, based on the dimensions shown on the Plans.

- C. **Filter Fabric (Riprap).** Fabric used for riprap shall be measured by the actual surface area covered to the nearest Square Yard. No allowance will be made for overlaps, drainage trenches, or cutoff trench unless otherwise shown on the Plans.
- D. **Geotextile Reinforcement Fabric.** The reinforcement fabric shall be measured by the actual surface area covered to the nearest square yard. No allowance will be made for overlaps.

709.05 BASIS OF PAYMENT.

The quantities measured as provided will be paid for at the Contract Unit Price complete and in place. Payment will be made under:

Pay Item	Unit
Geotextile Fabric Type ____	Square Yard

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

**SECTION 710
TEMPORARY BYPASS**

710.01 DESCRIPTION.

This work consists of constructing, maintaining, and removing of roads, approaches, and structures necessary to provide a temporary road around construction operations. The temporary bypass shall be provided with adequate signs, barricades, warning lights, markers, and other traffic control devices for the protection and guidance of traffic according to Section 107, the laws of the State of North Dakota and the latest edition of the MUTCD.

The location of the temporary structure and bypass shall be approved by the Engineer.

710.02 CONSTRUCTION REQUIREMENTS.

The temporary bypass shall have a roadway width of not less than 24 feet, capable of carrying the legal load limit safely. It shall have a waterway opening sufficient to provide for the stream flow during the time the structure is in place. The type and details of the structure shall be the Contractor's responsibility.

The temporary bypass and approaches shall be smooth, well drained, and shall have no grades greater than 7 percent without written permission of the Engineer. The roadways shall be maintained in a safe and passable condition at all times. When specified, surfacing shall be provided and maintained in a condition satisfactory for all-weather use. Any material required for maintenance of surfaced roadways shall be furnished at the Contractor's expense.

The Contractor shall assume any and all liability for damage resulting from the neglect or failure to safeguard highway traffic or property.

The temporary bypass shall not be removed until the new structure is opened to traffic and removal is authorized by the Engineer. Removal shall include a full clean-up of the site, complete removal of all structures, etc.; and restoration of the area to its original condition to the satisfaction of the Engineer.

The Contractor shall maintain traffic on the bypass or bypasses; and furnish assistance to traffic, if required.

710.03 METHOD OF MEASUREMENT.

Each temporary bypass shall be designated by its station number; and for the purpose of measurement and payment, it shall be considered as a complete and separate unit.

710.04 BASIS OF PAYMENT.

The basis of payment shall be the Contract Unit Price bid for "Temporary Bypass."

This payment will be full compensation for all labor, materials, and equipment necessary to complete the work.

The furnishing of, maintenance of, and payment for all signs, barricades, warning lights, and other traffic control devices shall be according to Section 704.

Where there is no Contract Unit Price for "Temporary Bypass," each temporary bypass ordered by the Engineer shall be paid for under Section 104.03.

SECTION 714 CULVERTS, STORM DRAINS, EDGE DRAINS, AND UNDERDRAINS

714.01 DESCRIPTION.

This work consists of installing culverts, storm drains, edge drains, and underdrains designed to intercept and carry off surface or underground water.

Culverts, storm drains, edge drains, and underdrains of the various types and sizes specified will, at times, be referred to as pipe or conduit in these Specifications.

714.02 MATERIALS.

A. Culverts and Storm Drains.

Materials shall meet the following:

Item	Section
Concrete Culvert and Storm Drain Pipe	830.01 A
Reinforced Concrete Culvert and Storm Drain Pipe	830.01 B
Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts, Underdrains, and Storm Drains	830.02 B
Corrugated Aluminum Alloy Culverts	830.02 C
Smooth Wall Steel Pipe Culverts	830.02 D
Polymer Coated Corrugated Steel Pipe	830.02 G
Corrugated Polyethylene Culverts	830.03 F

Mortar shall consist of a mixture of one part Portland Cement to two parts mortar sand, and sufficient water to furnish proper consistency.

All materials must be approved by the Department before incorporation into the work.

When shown as conduit in the Contract, the Bidder may choose permissible options in types of pipe for culverts. The Bidder shall be aware of the minimum cover requirements of the conduit options. The options will be shown in the Proposal.

At locations where new end sections are to be placed on existing pipe, the Contractor is required to identify whether the type of end section needed is male or female.

B. Underdrains.

Materials shall meet the following:

Item	Section
Underdrain Granular Fill Material (Screen Analysis only)	816.02 A.1
Perforated, Corrugated Polyethylene, or Plastic Pipe	830.03 A.4

C. Bridge Approach Drains.

Materials shall meet the following:

Item	Section
Concrete Class AE	802
Precast Reinforced Concrete Pipe for Catch Basin	830.01 B
Corrugated Metal Pipe	830.02 B
Plastic or PVC Pipe	830.03
Grates, Frames, and Boxes	834.02 B, 834.02 C, or 834.02 D

D. Edge Drains.

Materials shall meet the following:

Item	Section
Trench Backfill	
Concrete Sand*	816.01
Size 4 or 5 Concrete Aggregate*	816.02
Permeable Trench Backfill Cl.2	816.03
Permeable Base Aggr. Cl.7	816.03
Class 43 Chips*	816.03
Perforated, Corrugated, P.E. Pipe	830.03 A.4
PVC Discharge Pipe	830.03 A.3
Geotextile Fabric	858

*Sieve analysis only.

714.03 CONSTRUCTION REQUIREMENTS.

If the existing drainage facilities become inoperable before the new drainage system is functioning, the Contractor shall provide sufficient temporary pumping and/or drainage facilities to keep the roadway drained to the satisfaction of the Engineer. The cost of providing sufficient temporary pumping and drainage shall not be bid separately but shall be included in the price bid for other items.

A. Culverts and Storm Drains.

1. **Excavation.** Trenches shall be excavated to allow for proper jointing of the pipe, and thorough compaction of the bedding and backfill material under and around the pipe.

The completed trench bottom shall be firm for its full length and width. Where required, the trench shall have a longitudinal camber of the magnitude specified.

The foundation for each type of bedding shall be adequate to furnish a uniform stable support. Where unstable material is encountered, it shall be removed to the depth directed by the Engineer and replaced with granular backfill. Rock, shale, or hard pan shall be removed to a depth 1 foot below the bedding elevation and replaced with granular backfill.

Excavation required in excess of 1 foot below the specified bedding elevation will be paid for as Common Excavation.

Disposal of excess excavation from pipe trenches shall be off the Right of Way, at a location approved by the Engineer.

2. **Bedding.** When bedding is required, it shall meet the details shown on the Plans or Standard Drawings.

Bedding for mainline pipe shall consist of the type of aggregate specified in the Plans. The bedding material shall be at least 2 feet thick beneath the pipe.

Bedding for approach pipe shall consist of bedding the pipe to a depth of not less than 10 percent of its total height. The bed shall be shaped to fit the conduit and shall have recesses shaped to receive the bell. Tamping shall be as specified above for mainline pipe.

3. **Handling and Assembly.** Any damage to the Polymer Coated Corrugated Steel Pipe during the shipment, handling, or installation of the culvert shall be repaired according to AASHTO M 243 or, if necessary, replaced. Any such repairs or replacements shall be done at the Contractor's expense and to the satisfaction of the Engineer prior to the acceptance of the purchase.
4. **Laying Pipe.** Laying of pipe shall begin at the downstream end. The lower segment of the pipe shall be in contact with the shaped bedding throughout its full length. Bell or groove ends of rigid pipe and outside circumferential laps of flexible pipe shall be placed facing upstream. Polymer Coated Corrugated Steel Pipe shall be handled at all times with equipment such as wide canvas slings and wide padded skids designed to prevent damage to the pipe coating.
5. **Joining Pipe.** Rigid pipe may be of "bell and spigot" or "tongue and groove" design unless one type is specified. Pipe sections shall be joined so the ends are fully entered and the inner surfaces are flush and even.

When jointing or tying of pipe sections is required, the jointing material and construction methods will be as shown on the Plans or Standard Drawings.

Flexible pipe shall be firmly joined by coupling bands.

6. **Relaid Pipe.** The Engineer will determine which sections of salvaged pipe are suitable for relaying.

All salvaged pipe shall be cleaned of foreign material before reinstallation.

Any connecting devices or seals needed to join pipe or end sections shall be furnished by the Contractor. The cost of these items shall be included in the price bid for "Relaying Pipe" or "Relaying End Sections."

7. **Backfilling for Pipe Installed in Embankments.** After installing the pipe on the required bedding, suitable backfill shall be placed along each side of the pipe in layers not exceeding 12 inches. Each layer shall be compacted to the required density. If a specified density is not required, compaction shall be according to Section 203.02 I.

All suitable excavated material may be used for backfilling, and the balance shall be placed in the roadway embankments. Soft, spongy, or other unsuitable material shall be placed on the slopes of the roadway embankment or wasted at locations acceptable to the Engineer.

Material around the sides and under the haunches of the conduit shall be thoroughly compacted.

8. **Backfilling for Pipe Installed in Trenches.** After the pipe is installed, the trench shall be backfilled with suitable material according to Section 210.
9. **Corrugated Polyethylene Pipe.** A minimum of 30 days after the pipe is installed, the Contractor (under the observation of the Engineer) shall pass a nine point mandrel or other approved object through the pipe to check for deformation. The mandrel diameter shall not be less than 95 percent of the inside diameter of the pipe. If the plastic pipe has deformed more than 5 per-

cent, it shall be replaced at the Contractor's expense. Another 30-day waiting period will commence upon installation of the replacement pipe.

10. **Connection to Manholes, Inlets, and Pipes.** If the proposed pipe or drain is to be connected to a manhole, inlet barrel, or pipe, the cost of materials, equipment and labor to cut the manhole, inlet barrel, or pipe entrance and to grout the connections shall be included in other items.

- B. **Smooth Wall Steel Pipe Culvert.** Smooth wall steel pipe culverts shall be installed using equipment that encases the hole as the earth is removed. Boring without the concurrent installation of the steel pipe will not be permitted. All joints in steel pipe shall be welded according to AWS D1.1. Steel pipe shall extend through the undisturbed fill and shall be installed without disrupting traffic or damaging the roadway grade and surface. Use of water in the process of boring or jacking is prohibited.

The borings shall be made in straight lines and to the grade and alignment shown. The flow line elevation at the starting point for jacking shall be within 0.1 foot of the staked grade; the flow line shall not be reversed at any point; and the line and grade at any point within the pipe shall not vary by more than 0.5 foot from the line and grade designated.

Only welders qualified for groove welded pipe position 5G shall be employed to splice smooth wall steel pipe culverts. Welders shall be qualified according to AWS D1.1 except full penetration shall not be required. The root pass and the remaining part of the weld, including the reinforcement, shall meet the requirements of AWS D1.1. Reinforcement shall not exceed 1/8 inch in height. The Department will accept the welding test results administered by an independent testing agency. The cost of welder testing and certification shall be the responsibility of the Contractor. A copy of the welder's qualification test certificate shall be furnished to the Engineer before the welder performs any welding. The Engineer has the right to require a requalification test at any time.

- C. **Underdrains.** Underdrains shall be constructed to the line, grade, and locations shown.

The perforated underdrain shall be encased in a granular fill trench section with the trench section enclosed with filter fabric. The filter fabric shall meet the requirements of Section 709.02, Filter Fabric Underdrain. The trench section shall be 1.5 feet wide and 2.0 feet deep. The underdrain shall rest on the filter fabric at the bottom of the trench, at the desired grade, prior to backfilling with the granular fill. No more than 1 inch of granular material may be used to adjust the pipe to grade. The filter fabric shall overlap approximately 12 inches.

Underdrain size and perforation layout shall be as shown in the Contract.

The PVC joints shall be solvent cemented using the manufacturer's recommendations.

Where a drain connects with a manhole, catch basin, or pipe, the connection shall be made at the Contractor's expense.

Backfill above the granular fill material shall be ordinary backfill as specified in Section 210.

- D. **Bridge Approach Drains.** Construction of bridge approach drains shall be as shown in the Contract.

Excavation shall be according to the details shown. The backfill shall be placed without disturbing the units, and shall be compacted to the same density as the adjacent embankment.

- E. **Edge Drains.** Edge Drains shall be constructed along the pavement edge as shown on the Plans. The drains shall be outletted at approximate intervals of 250 feet and at low points in the flow line of the edge drain.

The drains shall be placed by a machine trencher capable of cutting the trench, lining the trench with a geotextile fabric, and laying the pipe in a continuous operation. The drains shall be placed at a minimum grade of 0.2 percent. Laser grade control will be required on the trenching machine whenever the pipe grades do not follow the pavement grades at a constant depth. The trenching equipment shall be designed and operated so the excavated material does not fall back into the trench. The excavated trench material shall be disposed of by the Contractor.

The trench backfill shall be compacted with a vibratory shoe compactor narrower than the trench, but not more than 2 inches less than the trench width. The trench backfill shall be compacted adequately to ensure that additional settlement will not occur.

When edge drains are installed adjacent to a permeable base material, the trench shall be wrapped with a Type D2 geotextile drain fabric. The fabric shall be pinned directly below the flow line of the permeable base material so the flow of water to the drain is not impeded. Concrete sand will not be used for trench backfill on projects using a permeable base material.

When edge drains are installed on a project with a non-permeable base material, the PE pipe shall be enclosed in a geotextile fabric sock. The Contractor may elect to use a Type D3 or Type D4 geotextile drain fabric for the sock.

Edge drains that outlet to the ditch shall be constructed concurrently with the longitudinal edge drains and laid at right angles to the roadway centerline. The discharge pipe shall be a PVC pipe laid at a minimum grade of 2 percent. The connection to the edge drain pipe shall be made with a non-perforated PE pipe placed with a 3-foot radius. Two drains coming together at a low point shall be connected to separate discharge pipes. The discharge trenches shall be constructed similar to the drains, but shall be backfilled with the existing soil. Headwalls shall be installed a minimum of 6 inches above the ditch grade. The discharge pipe shall be inserted and coupled to the headwall with grout. The uppermost point of the headwall shall be placed flush with the roadway inslope. The inslope shall be shaped to conform to the sides and toe of the headwall. The headwall and rodent screen shall be installed at the same time the outlet pipe is installed.

Each headwall shall be provided with a rodent screen that fits snugly into the headwall so mice and other rodents are unable to enter the drain. The rodent screens must be removable, the Contractor will not be permitted to grout the screens into place.

Edge drains that outlet to a storm sewer system shall be coupled to the inlet by use of grout, rubber or plastic gaskets, or by a gasket joint inserted into a thermoplastic

coupling cast into the inlet, manholes, or pipe. The connections to the storm sewer shall be made concurrently with the installation of the drain. The cost of the connections to the storm sewer shall be included in the bid item "Edge Drain."

Ends of the drainage line where outlets are not required shall be capped.

All joints shall be connected securely according to the manufacturer's recommendations.

Construction equipment will not be allowed on the edge drain until it is properly protected.

- F. **Drainage.** All drainage shall be in accordance with Section 722.03 M.

714.04 METHOD OF MEASUREMENT.

- A. **Culverts and Storm Drains.** Pipe of different types and sizes, both new and relaid, will be measured by the Linear Foot in place.

End sections will be measured by the number of units installed.

Branch connections and elbows will be included in the length measured for pipe.

Excavation, disposal of excess excavation, and backfill for pipe will not be measured for payment.

Where alternate types of pipe are specified, they will be designated as "Pipe Conduit" and will be measured by the Linear Foot along the top of the pipe, as shown on the Standard Drawing. Flared end sections will not be measured separately but will be considered as part of the conduit. Each conduit will be measured to the nearest foot.

Grates will be measured by the number of units installed.

- B. **Smooth Wall Steel Pipe Culvert.** Smooth wall steel pipe culvert will be measured by the Linear Foot of the various sizes in place, complete, and accepted. Any connectors for adapting other pipe or end sections will not be measured but shall be included in the bid item "Smooth Wall Steel Pipe Culvert."

- C. **Underdrains.** If a Pay Item is not shown on the Plans, underdrains of different types and sizes will be measured by the Linear Foot in place.

Granular Fill will be measured by the Cubic Yard computed from the width and depth of the trench as specified or approved by the Engineer. The volume displaced by the underdrain will be deducted.

- D. **Bridge Approach Drains.** Bridge approach drains, including Headwalls, will be measured by the Unit.

- E. **Edge Drains.** Edge drains shall be measured by the Linear Foot (parallel to the roadway) of "Edge Drain Permeable Base" or "Edge Drain Non-Permeable Base" installed and accepted by the Engineer. No deduction in length will be made for outlet structures installed along the drain. The Contract Unit Price bid shall in-

clude all costs for trenching, geotextile fabric, trench backfill, compaction, caps, manhole connections, and other associated work.

The headwalls will be measured by the number of "Headwalls, Precast Concrete, 4 In." installed and accepted by the Engineer. The Contract Unit Price bid shall include payment for the headwall, the discharge pipe, the 3-foot radius pipe connection, trenching, backfilling, compaction, rodent screen, connections, and other associated work.

714.05 BASIS OF PAYMENT.

Payment will be made at Contract Unit Prices for the following:

Pay Item	Pay Unit
Pipe (Type and Size)	Linear Foot
End Section (Type and Size)	Each
Grates	Each
Relaying Pipe (Type and Size)	Linear Foot
Relaying End Section (Type and Size)	Each
Underdrain Granular Fill Material	Cubic Yard
Bridge Approach Drains	Each
Edge Drain Permeable Base	Linear Foot
Edge Drain Non-Permeable Base	Linear Foot
Headwalls, Precast Concrete, 4 In.	Each

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

Unless otherwise specified, excavation for culverts, storm drains, underdrains, and edge drains, including excavation below flow line grade and excavation for imperfect trench, bedding, and backfill will not be paid for but shall be included in the pipe item. Disposal of unsuitable material will not be paid for but shall be included in the pipe item.

Geotextile fabric used with underdrains and edge drains will not be paid for separately, but will be included in the pipe items.

Granular fill or trench backfill used with underdrains and edge drains will not be paid for separately, but will be included in the pipe items.

SECTION 720 MONUMENTS AND RIGHT OF WAY MARKERS

720.01 DESCRIPTION.

This work consists of furnishing and installing concrete alignment monuments and Right of Way markers. A Right of Way marker (Witness Post) is defined as the post set

beside the Right of Way Monument. This post guards the monument from destruction and provides a means of locating the monuments. The Right of Way Monument is defined as the iron monument (pin) placed at the right of way boundary line.

720.02 MATERIALS.

Materials shall meet the following:

Item	Section
Concrete	802
Reinforcing Steel	836.02 A

720.03 CONSTRUCTION REQUIREMENTS.

- A. **Monuments.** Monuments shall be constructed of Class AE Concrete to the dimensions and details given on the Standard Drawings. Monuments shall be set upon a firm base and the backfill compacted so no movement of the monument occurs after installation. The top of the monument when installed shall be approximately 6 inches below the finished road grade. Existing monuments uncovered during the work shall not be disturbed or removed until referenced by a Registered Land Surveyor, approved by the Engineer.

All concrete alignment monuments shall be precast. Precast concrete alignment monuments will be furnished and placed by the Contractor on all centerline alignment PI's, section corners, quarter corners, and on section lines crossing the centerline alignment as shown on the Standard Drawings. When centerline alignment PI's are located outside the highway right of way, an iron monument (defined in the Standard Drawings) may be placed in lieu of the precast concrete alignment monuments. The precast concrete alignment monuments shall be placed on all grading projects, and all other projects where existing monuments will be disturbed. A licensed Registered Land Surveyor (including the Contractor's surveyor) must be involved in the placement and recording of all Public Land Corners (section corners and quarter corners), section line crossings, and PI monuments as required by the N.D.C.C. The costs associated with concrete monuments are to be included in the pay item "Monuments". A licensed Registered Land Surveyor is not required to be involved in the placement of the other alignment monuments, right of way markers, and right of way monuments. The price bid for "Monuments" shall include the cost of materials, installation, and the Registered Land Surveyor as required.

- B. **Right of Way Markers.** Right of Way markers shall be constructed of Class AE Concrete or recycled Plastic to the dimensions and markings of the markers as shown on the Standard Drawings. Installation of the Right of Way markers shall be at the locations shown in the Contract.

720.04 METHOD OF MEASUREMENT.

Monuments and Right of Way Markers will be measured by the Unit complete and in place.

720.05 BASIS OF PAYMENT.

Payment will be made at Contract Unit Prices for the following:

Pay Item	Pay Unit
Monuments	Each
Right of Way Markers	Each

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

SECTION 722 MANHOLES, CATCH BASINS, AND INLETS

722.01 DESCRIPTION.

This work consists of constructing and adjusting manholes, catch basins, and inlets, including the furnishing or resetting of necessary metal frames, covers or gratings, valve boxes, or other accessories to new lines and grades where such accessories are public property.

Any damaged parts resulting from construction operations shall be replaced at the Contractor's expense.

722.02 MATERIALS.

Materials shall meet the following:

Item	Section
Concrete Class AE	802
Precast Reinforced Concrete Pipe Manholes Frames, Tops, Covers, Fittings, and Gratings	830.01 B or C 834.02 C or D
Reinforcing Steel	836.02 A
Brick	848
Concrete Masonry Units	848

Mortar shall be a compound of one part Portland Cement to two parts of sand by volume, to which lime may be added not to exceed 10 percent of the cement by weight. All materials used are subject to approval.

722.03 CONSTRUCTION REQUIREMENTS.

- A. **Excavation.** Excavation for catch basins, manholes, and inlets shall provide adequate room for construction of the item according to details shown. Disposal of excess excavation from manhole, catch basin, and inlet installation shall be off the right of way, at a location approved by the Engineer.
- B. **Brick Masonry Construction.** Brick walls shall be 8 inches thick. The brick shall be thoroughly wetted before placement and shall be laid with full mortar joints.

Brick masonry shall be cured for 48 hours by covering exposed surfaces with wet burlap held in place vertically and horizontally by lattice work or some similar method.

- C. **Precast Concrete Masonry Units.** Concrete masonry units shall be placed as specified in 722.03 B.
- D. **Precast Reinforced Concrete Pipe Manholes, Inlets, and Catch Basins.** Reinforced concrete sewer pipe shall be used for this purpose. When this type of construction is used, the joints shall be made by one of the following methods:
 - 1. Portland Cement Mortar
 - 2. Rubber Gaskets
 - 3. Cold Applied Preformed Plastic Gaskets
- E. **Concrete Construction (Cast-in-Place).** The composition, consistency, placement, form work, curing, and protection of the concrete shall meet Section 602.

The finished concrete surface shall present a neat and smooth appearance. Honeycomb shall be filled with cement mortar mixed in the same proportions used in the concrete for the work.
- F. **Concrete Base (Pre-Cast or Cast-in-Place).** The thickness and other dimensions of the base shall be as specified. The invert channel shall be the true shape of the lower half of the pipe or sewer. The bottom edge of the barrel for manholes, catch basins, and inlets shall be cut or precast flat to fit the base. The joint between the base and the wall shall be grouted with cement mortar.
- G. **Pipe Connections.** Pipe or tile placed in the concrete base for inlet or outlet connections shall extend through the walls a sufficient distance to allow for connections. The concrete shall be constructed around the pipe or tile to prevent leakage along their outer surface. The inside ends shall be flush with or protrude through the inside walls, and the pipe shall be the same size and kind as those they connect with on the outside. The cost of materials, equipment and labor to make the connections shall be included in other items.
- H. **Reinforcement.** The method of reinforcement shall meet Section 612.
- I. **Placing Castings.** Castings shall be set in full mortar beds or otherwise secured as specified. Castings shall be set accurately to the correct elevation so no subsequent adjustment is necessary.

Catch basins, manholes, or inlets shall be constructed no more than 6 inches below Plan grade, and the casting brought to grade by use of precast concrete adjusting rings.

- J. **Backfill.** Backfill shall be deposited and compacted in horizontal layers not to exceed 6 inches loose depth until the elevation of the finished grade is reached. Compaction shall be secured in two steps: 1) by watering each layer if dry (the water content of the material used shall not exceed the optimum moisture content); and 2) by tamping with approved mechanical rammers or by hand tamping

with heavy iron tampers. Hand tampers shall not have a tamping face exceeding 25 square inches. The backfill shall be compacted to a density equal to at least 85 percent of AASHTO T 180.

- K. **Cleaning.** All catch basins, manholes, and inlets shall be cleaned of accumulations of silt, debris, or foreign matter, and be free from such accumulations at the time of final inspection.
- L. **Adjustments to Existing Units.** Existing manholes, catch basins, inlets, and utility appurtenances shall be adjusted to the elevation, grade, or dimensions as specified. Castings shall be carefully removed and reinstalled as indicated. Adjustments to the structure walls may be made by the use of brick, solid concrete blocks, precast ring, or Class AE concrete so that a seat of proper dimensions may be reconstructed to receive the casting, grating, or cover. If the top of the existing structure is weak and faulty, it shall be replaced as directed, and the extension completed.

Upon completion of the adjustment, all surplus material shall be removed and the structure and work site shall be left in a neat and clean condition.

- M. **Maintenance of Drainage.** If the existing drainage facilities become inoperable before the new drainage system is functioning, the Contractor shall provide sufficient temporary pumping and/or drainage facilities to keep the roadway drained to the satisfaction of the Engineer. The cost of providing sufficient temporary pumping and drainage shall not be bid separately but shall be included in the price bid for other items.

722.04 METHOD OF MEASUREMENT.

- A. **Catch Basins and Inlet.** These items will be measured by the Unit. The unit consists of the base, the casting, cover, and grate. Casting lengths are specified in the Plans.
- B. **Manholes and Manhole Risers.** Manholes will be measured as a Unit consisting of the base, the castings, and the cover. Manhole Risers will be measured by the Linear Foot of riser as measured from the base to the precast cover or the casting.
- C. **Adjustment of Manholes, Catch Basins, Inlets, Pipe Junctions, and Utility Appurtenances.** These items will be measured by the Unit complete and in place.

Excavation, embankment, and disposal of unsuitable or excess material will not be measured but will be included in Pay Items.

722.05 BASIS OF PAYMENT.

Payment will be made at Contract Unit Prices for the following:

Pay Item	Pay Unit
Manholes (Size)	Each
Manhole Riser (Size)	Linear Foot
Catch Basins	Each
Inlets	Each
Adjust Manhole	Each

Adjust Catch Basin	Each
Adjust Inlet	Each
Adjust Utility Appurtenance	Each

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

SECTION 724 WATER MAINS, WATER LINES, AND SEWER LINES

724.01 DESCRIPTION.

This work consists of furnishing and installing water and sewer lines and appurtenances of the types and sizes required, in full compliance with the requirements of the North Dakota State Plumbing Code, the North Dakota State Health Department, and all City ordinances.

724.02 MATERIALS.

A. Pipes.

1. **Reinforced Concrete Sewer Pipe** shall meet Section 830.01 B.
2. **Ductile Iron Pipe** shall meet Section 830.02 A.
3. **Polyvinyl Chloride Pipe** shall meet the requirements of American Water Works Association (AWWA) C 900 with latest revisions and as specified in Section 830.03. The PVC pipe shall be SDR-18, Class 150.
4. **Copper Pipe** for water service shall be type "K" and shall meet ASTM B 88.

B. **Joints and Fittings** shall be as shown on the Plans and shall meet to the requirements of AWWA. Copper services shall have flared or compression fittings as required by the City involved in the Contract.

C. **Rubber Gaskets** shall meet ASTM C 443.

D. **Gate Valves** shall meet AWWA C 500, and shall have nonrising stems, O-ring seals, and 2-inch operating nuts that open counter-clockwise.

E. **Butterfly Valves** shall meet AWWA C 504, and shall be as specified in the Contract.

F. **Valve Boxes** for gate valves shall be as specified in the Contract.

G. **Hydrants** shall be equipped as shown in the Contract.

- H. **Tapping Saddle and Tapping Valve or Tapping Sleeve and Tapping Valve** shall be as shown in the Contract.
- I. **Aggregates.** Bedding and backfill shall be a granular material with 100 percent passing a 2-inch sieve and no more than 35 percent passing a No. 200 sieve.
- J. **Concrete** for cradles, anchors, and thrust blocks shall be Class AE.
- K. **Corporation Stops (Cocks), Curb Stops, and Curb Boxes** shall be as specified on the Plans or Standard Drawings.

All materials must be approved by the Engineer before incorporation into the work.

724.03 CONSTRUCTION REQUIREMENTS.

- A. **General.** Water mains shall not be constructed in the same excavated trench as sanitary sewer pipes. At least 10 feet of horizontal clearance should be maintained between water mains and sewer pipes. When it is not possible to maintain the 10 feet horizontal clearance, or when it is necessary for the main and pipe to cross over, a minimum vertical distance of 18 inches shall be maintained.
- B. **Excavation and Trenching.** Trenches shall be excavated to a width of 24 inches wider than the outside diameter of the pipe with a minimum width of 30 inches. Sheathing and bracing shall be provided to support the excavation.
 - 1. **Excavation.** Trenches shall be excavated so the water main or sewer pipe can be laid on 3 inches of bedding material. If unstable material is encountered, it shall be removed and replaced with backfill acceptable to the Engineer. Rock, shale, or hard pan shall be removed to a depth of 1 foot below the bedding elevation. Disposal of excess excavation from water-appurtenance installation shall be off the Right of Way, at a location approved by the Engineer.
 - 2. **Bedding.** The bedding material shall be shaped so that after the pipe is laid, the bedding extends up the sides of the pipe a distance of 1/3 the pipe diameter. The bedding shall be tamped to provide uniform bearing along the entire length of the pipe.
 - 3. **Backfilling.** Backfill material shall be as specified in Section 724.02 I, and placed to a depth of 3 inches over the top of the pipe. The backfill material shall be placed and compacted without lateral displacement of the pipe. The remainder of the trench shall be backfilled with suitable material excavated from the trench. This material shall be placed in a maximum of 12-inch layers and each layer compacted to a density of not less than 85 percent maximum dry density at optimum moisture according AASHTO T 180, or as specified.
- C. **Water Main Requirements.**
 - 1. **Laying Water Mains.** Each joint or fixture shall be inspected and the interior cleaned before lowering into the trench. Dirt and other contaminants shall be prevented from entering the pipe during installation. Water encountered during laying operations shall be drained or pumped so no water enters the pipe.

Each joint shall be centered, pushed completely home, and the joint fastened using the manufacturer's recommendations.

Where connections to existing lines are required, the Contractor shall notify the line owners at least 24 hours in advance, so arrangements for temporary service can be made, or agreement reached on when the service can be interrupted.

2. **Testing and Disinfecting Lines.** All joints shall be tested before backfilling. Where dictated by construction requirements, the line may be tested in segments. After the pipe trench has been partially backfilled, all new pipe or valve sections shall be subjected to a hydrostatic pressure test. The necessary taps shall be provided without charge by the city. The test section shall be filled with water and the pressure shall be gradually increased. Any defects found shall be repaired at the Contractor's expense. The final pressure test shall be at 150 psi and held for one hour. The Contractor shall furnish all equipment and material necessary to make the pressure test. After all leaks have been repaired, all water lines that carry water for human consumption shall be disinfected. Lines to be disinfected shall be completely filled with a water solution containing a residual chlorine level of at least 100 parts per million and allowed to stand full for a period of not less than one hour. After the disinfecting period, the solution shall be drained or flushed from the line.
3. **Thrust Blocks.** Major fixtures or fixtures that could blow off the line under pressure shall be braced by a cast-in-place concrete thrust block. The block shall be cast between the fixture and the undisturbed vertical trench wall with a minimum bearing surface of 2 square feet against the vertical wall.
4. **Hydrants.** Hydrants shall be placed in approximately 1/2 cubic yard of bedding material to take up all water from drip valves. The hydrants shall be set on a concrete pad 6 inches thick and 18 inches square.
5. **Reset Hydrant.** Hydrants to be reset shall either be furnished by the city or salvaged during construction. Installation shall be according to Section 724.03 C.4.
6. **Backfill.** During backfilling, the hydrants, valve boxes, or other vertical fixtures, shall be held vertical and the top adjusted to the elevation established for the various fixtures.
7. **Marking Tape.** The Contractor shall furnish and install marking tape 2 feet above the top of all water mains installed. The tape shall be non-detectable with a minimum width of 5 inches. The tape shall be blue in color with the words "CAUTION, WATER LINE BELOW" imprinted on the tape in black capital letters.
8. Using a method approved by the Engineer, the Contractor shall provide temporary service to properties whose services will be interrupted for more than eight hours. If the Contractor intends to perform the work without providing temporary services, all affected property occupants shall be notified, in writing, at least 24 hours in advance of the service interruption. At a minimum this notice shall contain the following information:

- a. Contractor contact information
- b. Engineer contact information (as directed by the Engineer)
- c. When the service will be interrupted
- d. Approximately when the service will be restored
- e. A general description of the work being done (e.g. “a fire hydrant is being installed”, “a valve is being installed”, “the water main is being replaced”, etc.)

Prior to distribution, the Engineer shall approve the form and language of the notice. At the same time the property occupants are notified, a copy of the final version shall be provided to the Engineer. If any service is interrupted for more than eight hours and temporary service has not been provided, the Contractor shall provide all necessary temporary services prior to continuing any other work. The cost of providing temporary water services and notifying property occupants, if required, shall be included in the bid item “Water Main.”

D. Water and Service Lines.

1. **General.** All connections to water mains shall be made with a corporation stop (cock).
2. **Laying Water Line.** Copper pipe shall be laid in a wavy line in the trench and shall be of a length of at least 2 feet greater than the distance from the corporation stop and the curb stop. The pipe shall not be less than 7-1/2 feet below the grade of the finished street.

The water service shall be well benched and offset on solid ground and all precautions taken to ensure stability. The water service line shall be looped at a 45 degree angle at the main into a gooseneck which shall be supported from displacement and settlement to prevent any strain on the corporation or connection. The curb stops and curb boxes shall be furnished by the Contractor.

3. **Testing.** All water connections shall be tested in place using city water pressure to determine defects in the water pipe. As soon as the water connection is completed and before any backfill has been placed, the corporation shall be opened and the connection examined for defects. Defects shall be repaired at the Contractor’s expense.

- E. **Sanitary Sewer Pipe Requirements.** The sewer pipe shall be laid from the lower end with the spigot ends pointing in the direction of flow. Each length shall be fully supported between joints and checked for line and grade before placing the next length. Each length shall be inspected and all dirt removed from the pipe and bell before being placed. Any defective pipe laid or any pipe that has its joint disturbed after laying shall be removed and replaced. Earth or other substances shall be prevented from entering the lines during construction.

Joints shall be tight and secure. Sewer pipe with pre-molded gaskets shall be pushed completely home and the gasket checked for proper positioning.

Where connections to existing lines are required, the Contractor shall notify line owners at least 24 hours in advance, so arrangements for temporary service can be made, or agreement reached on when the service can be interrupted.

724.04 METHOD OF MEASUREMENT.

- A. **Water Mains.** Water mains of the various types and sizes specified will be measured by the Lineal Foot through fittings and from centerline of pipe to centerline of pipe complete and in place.
- B. **Butterfly Valves and Gate Valves.** These items will be measured by the unit complete and in place.
- C. **Hydrants and Reset Hydrants.** Hydrants of the types and sizes specified will be measured on an individual basis (Each) complete and in place.
- D. **Excavation.** Excavation will be measured by the Cubic Yard. Disposal of excess excavation will not be measured for payment.
- E. **Aggregates.** Aggregates will be measured by the Ton or Cubic Yard complete and in place.
- F. **Tapping Saddle (or Sleeve) with Tapping Valve and Box.** These units will be measured on an individual basis (Each) complete and in place.
- G. **Exceptions.** Excavation, bedding and backfill material, marking tape, etc., not listed on the Plans as pay items, will not be measured for payment but shall be included in other bid items.
- H. **Sewer Lines.**

Sewer lines of the various sizes and types will be measured by the Linear Foot in place with no deduction for lengths through manholes. Where two different sizes enter or leave a manhole, each size will be measured to the center of the manhole.

Branch connections, bends, or other fixtures will be included in the length measurement.

- I. **Water Service Lines.** Water service lines will be measured by the Linear Foot of water service in place. The water service lines will be measured horizontally from the centerline of the water main to the end of the service. The unit price is to include furnishing corporation stop, curb stop, and curb box; and connecting, placing, and testing the complete connection from the corporation to the curb stop. In the event the Contractor is installing PVC water main, the double strap bronze saddle will also be included in the unit price bid per Linear Foot of water service.
- J. **Fittings.** Ductile fittings will be measured by the pound.

724.05 BASIS OF PAYMENT.

Payment will be made at Contract Unit Prices for the following:

Pay Item	Pay Unit
Water Mains	Linear Foot

Butterfly Valves	Each
Gate Valves	Each
Hydrants	Each
Reset Hydrants	Each
Excavation	Cubic Yard
Aggregates	Ton, Cubic Yard
Tapping Saddle (or Sleeve) with Tapping Valve and Box	Each
Sewer Lines	Linear Foot
Water Service Lines	Linear Foot
Fittings (Ductile Iron)	Pound

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

Items not listed as pay items on the Plans and Proposal Forms shall be included in the price bid for other items.

SECTION 740 DAMP-PROOFING AND FABRIC WATERPROOFING

740.01 DESCRIPTION.

This work consists of furnishing materials and placing dampproofing and fabric waterproofing on surfaces and areas specified.

740.02 MATERIALS.

Materials shall meet the following:

Item	Section
Primer	824.01
Asphalt	824.02
Woven Cotton Fabric	824.03
Black Polyethylene Membrane	824.04

740.03 CONSTRUCTION REQUIREMENTS.

- A. **General.** Dampproofing and waterproofing shall be done in dry weather and when the air temperature is above 40°F. The asphalt shall be heated to a temperature between 300°F and 350°F, and shall not be locally overheated. The heating kettles shall be equipped with thermometers. The fabric shall be stored in a dry protected place. Damaged fabric shall not be used.
- B. **Dampproofing.** The surface on which the dampproofing is applied shall be dry and clean.

Two coats of primer shall be applied at the rate of 75 square feet per gallon per coat. The first prime shall be dry before the second prime is applied. After the second prime is dry, the first asphalt seal coat shall be applied at the rate of 90 square feet per gallon per coat. After the first coat has been in place for at least ten hours, a second coat of asphalt shall be applied in the same manner as the first coat. Asphalt seal shall be applied by brush only.

Care shall be taken not to disfigure any other parts of the structure by dripping or spreading of the prime or asphalt.

- C. **Fabric Waterproofing.** Two coats of primer shall be applied at rate of 75 square feet per gallon per coat. The first prime coat shall be dry before the second prime coat is applied. The asphalt tack coat shall be applied after the last prime coat is dry. While the asphalt is still tacky, the fabric shall be applied as shown in the Contract. Successive layers of fabric shall be tacked with asphalt. After the fabric has set, it shall be covered with a coat of asphalt heavy enough to conceal the weave of the fabric. Damaged waterproofing shall be repaired at the Contractor's expense.
- D. **Black Polyethylene Membrane.** Black Polyethylene Membrane may be used in lieu of fabric waterproofing at no additional expense to the Department.

Concrete surfaces shall be wood floated or smooth formed. The surface shall be dry and free of all dust, stones, debris, and sharp protrusions.

Primer shall be applied by brush, roller, or spray at the rate of 300 to 800 square feet per gallon depending on the porosity of the surface. Primer shall dry at least one hour but not to exceed 36 hours.

The membrane shall be rolled into the primer eliminating all wrinkles and bubbles and producing a smooth finish. All joints shall be lapped a minimum of 2-1/2 inches. Both edges of the laps and all exposed edges of the membrane shall be sealed with joint sealing mastic.

Ambient, surface, and material temperatures shall be over 40° F. during application.

740.04 METHOD OF MEASUREMENT.

Dampproofing and waterproofing of the different types will be measured by the Square Yard complete and in place.

740.05 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Prices for the following:

Pay Item	Pay Unit
Dampproofing	Square Yard
Fabric Waterproofing	Square Yard

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

SECTION 744 INSULATION BOARD (POLYSTYRENE)

744.01 DESCRIPTION.

This work consists of furnishing and installing extruded expanded polystyrene insulation board.

744.02 MATERIALS.

The insulation board shall meet Section 868.

744.03 CONSTRUCTION REQUIREMENTS.

- A. **Subgrade Preparation.** The compaction requirements for the soil on which the insulation material is to be placed shall be specified. The surface on which the insulation board is to be placed shall be leveled and smoothed so deviations from a 10-foot straightedge do not exceed 1/2 inch. In lieu of leveling the subgrade, a layer of sand may be placed on the subgrade, then compacted and leveled to the design subgrade elevation, and smoothed to comply with the above requirement.
- B. **Installation.** The boards shall be placed in a stepped pattern so the transverse joints are not continuous. If two or more layers of insulation are used, each succeeding layer shall be placed to cover joints in the preceding layer. No joint shall be closer than 6 inches to a joint in a lower layer.

Joints shall be tight and no gaps over 1/4 inch shall remain.

A minimum of two wooden skewers, 6-inch by 3/8-inch, shall be driven in each board. Skewers shall be driven at an angle until flush with the board's surface. Skewers shall be used in each board of each layer.

- C. **Cover Material.** The first lift of material placed on the insulation shall be a minimum of 12 inches thick (loose), and it shall be end dumped and spread uniformly over the insulation.

All material placed on top of the insulation shall be placed by light trucks or loaders, and all compaction shall be by rubber-tired rollers or vibratory compactors.

- D. **Traffic.** No public traffic or additional construction equipment shall be permitted on the insulation until all fill on top of the insulation is completed and compacted.

744.04 METHOD OF MEASUREMENT.

Insulation board will be measured by the Board Foot complete, in place, and accepted.

744.05 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Insulation Board	Board Foot (bd.ft.)

This payment will be full compensation for all labor, equipment, and material necessary to complete the work.

SECTION 748 CURB AND GUTTER

748.01 DESCRIPTION.

This work consists of constructing curb, gutter, or combination curb and gutter.

748.02 MATERIALS.

Materials shall meet the following:

Item	Section
Materials for Bituminous Curbing	408
Concrete Class AE	802
Curing Materials	810
Base Material	816
Joint Materials	826
Expansion Joint Material	826.02 C or 826.02 D
Reinforcing Steel	836

748.03 CONSTRUCTION REQUIREMENTS.**A. Cast-in-Place Concrete Curb and Gutter.**

1. **Equipment.** Curb and Gutter shall be constructed using a slip-form machine or fixed forms. Fixed forms shall be full depth.
2. **Excavation.** The area for placing the curb shall be compacted to a firm, even surface. All soft and unsuitable material shall be removed, replaced, and compacted with suitable material.
3. **Base.** A base aggregate, when specified, shall be placed to the required section and uniformly compacted.

4. **Mixing, Placing, and Finishing.** Concrete shall be proportioned and mixed according to Section 802. The foundation shall be thoroughly moistened before placing concrete. The concrete shall be consolidated by vibration. The concrete shall be struck off to the proper cross section. The exposed surfaces shall be floated with a moistened wood float until all irregularities have been removed. The final surface finish shall be obtained by uniformly brushing the surface. Side forms shall be left in place until the concrete has hardened enough for form removal without damaging the concrete.

All honeycombed surfaces shall be corrected by using a mortar composed of one part cement and two parts sand. Severely honeycombed areas shall be removed and replaced.

The top and face of curbs shall be checked with a 10-foot straightedge and all variations greater than 1/4 inch in 10 feet shall be corrected before the final finish. If the curb cannot be corrected, out-of-tolerance sections shall be replaced at the Contractor's expense.

5. **Use of Water.** When weather conditions cause rapid drying of the pavement surface a fine mist or fog surface for interim curing. Use of brushes to apply water and use of water to facilitate finishing shall not be permitted.
6. **Joints and Joint Sealing.** All joints shall be formed and placed at the specified intervals. When constructed adjacent to concrete pavement, joints shall match the pavement joints. Joint sealing shall be as specified.
7. **Curing.** Concrete shall cure for 72 hours. All surfaces not protected by forms during this period shall be covered with a curing compound.
8. **Backfill.** After the concrete has set sufficiently, the spaces in front and back of the curbing shall be filled and compacted to the required elevation with suitable material.
9. **Operational Limits.** Operational limits shall meet Section 602.03 G.

B. **Precast Concrete Curbing.**

1. **Excavation.** Excavation shall meet Section 748.03 A.2.
2. **Base.** Base shall meet Section 748.03 A.3.
3. **Installation.** Precast curbing shall be laid on a uniform bedding true to line and grade. Care shall be taken so the dowels are free in the pipe sleeves and the weight of the unit is carried by the bedding and not by the dowels.

Units which are broken, cracked, or otherwise damaged will not be accepted.

4. **Surface Finish.** The surface shall meet Section 748.03 A.4.
5. **Joints.** All joints shall be formed according to the Plans or as otherwise directed.
6. **Backfill.** After the curb has been set to line and grade, the spaces in front and back of the curbing shall be filled and compacted to the required elevation.

C. Bituminous Curbing.

1. **Excavation.** Excavation shall meet Section 748.03 A.2.
2. **Base.** Base shall be placed as shown in the Contract. After the base has been uniformly compacted, a prime coat shall be applied of the type, grade, and amount specified.
3. **Preparation of Bed.** The area on which the curbing is placed shall be thoroughly cleaned of all objectionable foreign materials. The surface shall be thoroughly dried. Before placing the bituminous mixture, it shall receive a tack coat of bituminous material of the type, grade, and amount specified on the Plans or as directed. The tack coat may be eliminated on a freshly primed base if approved by the Engineer.
4. **Placing.** Bituminous curbing shall be constructed so the required cross section is produced and a uniform texture, shape, and density is obtained.
5. **Painting and Sealing.** When sealing or painting is required, it shall be performed only on a curbing which is clean and dry, and only under conditions approved by the Engineer.
6. **Backfill.** The spaces in front and back of the curbing shall be filled to the required elevation with suitable material and compacted to the satisfaction of the Engineer.

748.04 METHOD OF MEASUREMENT.

- A. **Curbing.** Curbing will be measured by the Linear Foot along the front face of the section at the finished grade elevation. Combination curb and gutter will be measured along the face of the curb. No deduction in length will be made for drainage structures installed in the curbing.

Where the curb is dropped through a concrete driveway, the curb and gutter measurement will be made as if the curb continued through the driveway.

- B. **Reinforcing Steel and Dowel Bars.** These items will not be measured for payment but shall be included in the unit price for curb.
- C. **Base Material.** This item will be measured by the Ton or by the Cubic Yard according to Section 109.

748.05 BASIS OF PAYMENT.

Payment will be made at Contract Unit Prices for the following:

Pay Item	Pay Unit
Curb Type _____	Linear Foot
Gutter Type _____	Linear Foot
Curb and Gutter Type _____	Linear Foot
Base Material _____	Ton or Cubic Yard
Curb and Gutter Type I Reinforced	Linear Foot
Curb and Gutter Type II	Each

Excavation costs shall be included in the price bid for Curb, or Curb and Gutter.

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

SECTION 750 SIDEWALKS AND DRIVEWAYS

750.01 DESCRIPTION.

This work consists of constructing concrete sidewalks and driveways.

750.02 MATERIALS.

Materials shall meet the following:

Item	Section
Concrete Class AE	802
Curing Materials	810
Base Material	816
Joint Materials	826
Preformed Expansion Joint Material	826.02 C or 826.02 D
Reinforcing Steel	836
Detectable Warning Panels	894.09

750.03 CONSTRUCTION REQUIREMENTS.

- A. **Forms.** Either fixed-forms or slip forms may be used. Forms shall be of wood or metal, straight and free from warp, and of sufficient strength to resist springing during the depositing and vibrating of concrete. Forms for use on curves shall be capable of installation to within 1/2 inch of the true curve. Forms shall be designed so they may be securely fastened together. All forms shall be clean and coated with a form release agent before the concrete is placed. Forms shall be the full depth of the concrete.
- B. **Excavation.** Excavation shall be made to the required depth and width that permits the installation and bracing of the forms. The foundation shall be shaped and compacted to an even surface conforming to the section shown in the Contract. All soft and yielding material shall be removed and replaced with acceptable material.
- C. **Base.** A base shall be placed to the required section and uniformly compacted.
- D. **Placing Concrete.** The foundation shall be thoroughly moistened immediately before placing concrete. Consolidation of concrete placed in the forms shall be by vibration.

- E. **Finishing.** Finishing shall be done with a wooden float which leaves a uniform surface with a sandy texture. The surface shall not be plastered. Sidewalks shall be transversely broomed to slightly roughen the surface.

All outside edges of the slab and all joints shall be edged with a 1/4-inch radius edging tool.

The curb section of driveways shall be finished according to Section 748.

The top face of any form or the contact face of a straight form shall not vary from a true plane by more the 1/4 inch in 10 feet.

All honeycombed surfaces shall be corrected by using mortar consisting of one part cement and two parts sand.

- F. **Use of Water.** When weather conditions cause a fine mist or fog, spray shall be applied to the concrete surface for interim curing. Use of brushes to apply water and use of water to facilitate finishing shall not be permitted.
- G. **Joints.** Expansion joints shall be placed in sidewalks at intervals as specified. Expansion joints shall be placed between the sidewalk and any abutting curb, pavement, driveway, or other structure; and they shall entirely separate the sidewalk from the abutting structure. Expansion joints shall have a thickness of at least 1/4 inch.

Hot poured bituminous joint filler shall be used for sealing isolation joints. The hot bituminous sealer shall meet the requirements of Section 826.02 A.1 or 2.

The sidewalk shall be divided into sections, as shown on the Plans, by dummy joints formed by a grooving tool or other acceptable means.

- H. **Curing.** Concrete shall be cured for 72 hours. All surfaces not protected by forms shall be covered by a curing compound during this period.
- I. **Backfill.** After the concrete has set sufficiently, the spaces along the sides of sidewalks and driveways shall be filled and compacted to the required elevations with select material.
- J. **Operational Limitations.** Operational limitations shall meet Section 602.03 G.
- K. **Detectable Warning Panels.** The panels shall be installed according to the manufacturer's recommendations.

750.04 METHOD OF MEASUREMENT.

- A. **Concrete Sidewalks and Driveways.** These items will be measured by the Square Yard of finished horizontal surface including integral curbs on driveways.
- B. **Base Material.** This item will be measured by the Ton or by the Cubic Yard.
- C. **Detectable Warning Panels.** Panels will be measured to the nearest Square Foot of surface in place.

750.05 BASIS OF PAYMENT.

A. Payment will be made at Contract Unit Prices for the following:

Pay Item	Pay Unit
Concrete Sidewalk	Square Yard
Concrete Driveway	Square Yard
Base Material	Ton, Cubic Yard
Detectable Warning Panel	Square Foot
Detectable Warning Panel - Retrofit	Square Foot

- B. Reinforcing steel will not be measured for payment but shall be included in the bid price for Concrete Sidewalk or Driveway.
- C. Excavation, backfill, expansion joint material, and other related miscellaneous items will not be paid for separately but the cost shall be included in the cost of the Sidewalk or Driveway.
- D. If base material is not specified as a pay item, the cost shall be included in the cost of the Sidewalk or Driveway.

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

**SECTION 752
FENCING - INSTALLATION AND RESETTING**

752.01 DESCRIPTION.

This work consists of constructing fences and gates including the removal of existing fences and resetting of fences in the locations shown on the Plans or as directed by the Engineer.

752.02 MATERIALS.

Materials shall meet the following:

Item	Section
Concrete Class AE	802
Posts	860
Chain Link Fence	860.01
Barbed Wire Fence	860.02
Woven Wire Fence	860.02 B

752.03 CONSTRUCTION REQUIREMENTS.

- A. **General.** The fence shall be erected on the Right of Way parallel to and one foot from the Right of Way line.

The bottom of the fence shall follow the contour of the ground except at grade depressions such as stream crossings, drainage ditches, or other locations where it is not practical. At such locations the fence shall span the depression, and the space below the bottom wire shall be closed with additional wire or fabric and posts of regular or extra length as acceptable to the Engineer.

- B. **Installing Line Posts.** All posts shall be placed as close to the intervals shown as conditions allow. At sharp changes in grade, extra posts shall be installed to maintain the wire or chain link the proper distance from the ground. All posts shall be aligned and plumb.

Posts shall be placed to the required depth and plumb. In unusual locations where the slope of the terrain makes it impracticable to set the posts plumb, the posts shall be set as directed by the Engineer.

Posts for chain link fence shall be set in concrete. Posts for barbed wire fence and woven wire fence shall be driven or set in holes. If soil conditions prevent proper driving of posts, a pilot hole may be drilled which shall be no larger than the diameter of the post minus one inch.

When posts are set in holes, the holes shall be large enough to allow proper tamping. Wood posts shall be set with the large end down. Backfill shall be placed in layers not to exceed 6 inches in loose depth; and it shall be compacted. When completed, all the excavated earth shall be used and the backfill shall be crowned slightly.

When solid rock is encountered, holes shall be drilled a minimum depth of 12 inches into the rock or to the required embedment depth of the post, whichever is less. The post shall be cut to provide the required height above the ground. The post shall then be grouted into the rock with a grout consisting of one part cement and two parts sand.

Posts damaged during handling or driving shall be replaced at the Contractor's expense.

Wood posts shall be grounded at every tenth post using a nine-gauge wire the full length of the post. The wire shall be stapled to the post before driving and placed so each line wire shall be stapled to it.

- C. **Corner and Brace Assemblies.** A horizontal angle in the fence having a deflection of more than 15 degrees shall be considered a corner and shall be braced accordingly. Brace assemblies may be required at other locations if directed by the Engineer.

Wood corner and brace posts shall be installed according to Section 752.03 B.

Steel corner and brace posts, when not set in concrete, shall be driven unless the posts are provided with anchors and brace plates. In this case the posts shall be set in holes and backfilled in the same manner as wood posts.

- D. **Installing Fence Wire.** All fence wire shall be pulled tight with hand stretchers either of the double block or lever type. The pulling and tightening of fence wire with tractors or trucks shall not be permitted.

1. **Barbed Wire and Woven Wire.** Wire shall not be stretched around corners but shall be cut and tied securely to each corner or brace post.

In erecting the fence any combination of splices, both factory and field, shall not exceed 3-in-1 spool of wire.

If a wire breaks after the fence has been erected, no more than two field splices per strand shall be permitted between brace assemblies.

Wires shall be placed on the side of the post away from the highway except on the inside of curves where they shall be placed on the highway side of the post so the wire pulls against the posts.

Staples shall be driven diagonally to the grain of the wood and shall be driven 3/4 of their length into the wood leaving room for the wire to move.

Wire shall be fastened to steel posts with wire clamps or fasteners designed for use with the posts.

2. **Chain Link Fence.** Fabric shall be placed on one side of the posts for a continuous run of fence. Fabric shall not be stretched around corner posts or past brace posts but shall be attached to each brace, gate, and corner post by stretcher bars threaded through the loops of the fabric and fastened to the posts with bands.

Splices in the fabric shall be made by weaving in a pre-bent wire of the same kind as that in the fabric.

- E. **Gates.** Gates shall be constructed and located as shown in the Contract.
- F. **Resetting Fences.** Existing fences shall be removed so the materials can be reset in the same condition as when removed. Unused portions of the salvaged fence shall be stockpiled at designated locations. New material for resetting the fence shall include staples or other fasteners. If any new posts, braces, or wire are required (as determined by the Engineer) payment for those new materials will be as provided under Basis of Payment. Installation shall meet Section 752.03 D.
- G. **Temporary Safety Fence.** The temporary safety fence shall be four feet high, colored bright orange and constructed of a polyethylene web. The weight of a 4-foot

by 100-foot roll shall be a minimum of 32 pounds. The fence shall be supported, at a minimum, by a 7-foot, 1.12-pound/foot channel steel post or an approved equal. Fencing placed across asphalt or concrete may be supported by barricades, delineator drums, or by other means approved by the Engineer. All supports used shall be capable of supporting the fence. The fence shall be securely attached to the supports and be maintained in good condition. The temporary fence installation shall be approved by the Engineer.

752.04 METHOD OF MEASUREMENT.

New, Temporary Safety Fence, and reset fence will be measured by the Linear Foot. Measurement will be along the top of the fence from outside to outside of end posts for each continuous run of fence. Additional wire or fabric at depressions will be measured as additional fence and added to the pay quantity.

Gates, corner assemblies, and double brace assemblies will be measured as completed units of the size and type specified.

752.05 BASIS OF PAYMENT.

The linear feet of fence reset, measured as provided, will be paid for at the Contract Unit Price bid for "Reset Existing Fence." This price shall be considered full compensation for clearing, for removing the existing fence, and for resetting the fence according to this Specification. It shall include the cost of any staples or other fasteners required. Payment for any new posts, braces, or wire furnished as directed by the Engineer shall be the invoice cost of the material, plus tax, plus the transportation charges to which shall be added 25 percent to cover all other costs and shall be in addition to the price bid per Linear Foot for "Reset Existing Fence."

Payment will be made at Contract Unit Prices for the following:

Pay Item	Pay Unit
Strand Barbed Wire Fence	Linear Foot
Woven Wire Fence	Linear Foot
Chain Link Fence	Linear Foot
Vehicle Gate	Each
Pedestrian Gate	Each
Corner Assembly	Each
Double Brace Assembly	Each
Reset Existing Fence	Linear Foot
Temporary Safety Fence	Linear Foot

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

SECTION 754 HIGHWAY SIGNS

754.01 DESCRIPTION.

This work item consists of furnishing, fabricating, and installing highway signs, delineators, and supporting structures.

754.02 MATERIALS.

- A. **General.** All materials furnished and used in this work shall be new, and shall meet the Plans, the Standard Drawings, Section 894 of the Standard Specifications, and the following requirements:

Signs, supporting structures, breakaway bases, anchor units, brackets, stringers, and hardware shall be fabricated to meet the dimensions, metal gauge, and bolt holes set forth in the Contract and Standard Drawings. All flat sheet sign backings shall be aluminum with reflective sheeting applied as specified.

The traffic control sign details not otherwise specified shall meet the MUTCD published by the Federal Highway Administration.

All sign faces shall be according to the detail drawings and the alphabets shown in the MUTCD, Standard Highway Signs, and Standard Alphabets, published by FHWA. Sign faces not detailed in these publications shall meet the detailed drawings shown in the supplementary Standard Highway Signs booklet published by the Department.

Regulatory, warning, and guide signs shall be detailed and dimensioned according to detailed drawings of the Standard Highway Signs booklet and Department supplement. These detail drawings are available to the sign fabricator upon request from the Department. Signs not illustrated in these booklets shall be as shown on the Standard Drawings. The last number in the sign numbers shown is the width of the sign required.

Variable message sign dimensions have been computed by the Department of Transportation in order to draft these signs by mechanical means. These message computations have been tabulated and shall be used to lay out these sign faces in the fabricator's shop. These tabulated sheets will be furnished to the Contractor upon request after the Contract has been awarded.

- B. **Concrete.** Concrete used in this item of work shall be Class AE Portland Cement concrete mixed and proportioned as specified in Section 802.
- C. **Reinforcing Steel.** The reinforcing steel shall meet Section 612.
- D. **Delineators.** Delineators shall meet Section 894.06.
- E. **Hardware and Fittings.** Signs, supporting structures, breakaway bases, anchor units, brackets, stringers, and all hardware and fittings shall meet Section 894.05 A.
- F. **Overhead Sign Structures.** Overhead structures shall meet Section 894.08.
- G. **Posts.** Posts shall meet Section 894.05 B.

754.03 CONSTRUCTION REQUIREMENTS.

- A. **Locating and Positioning Signs and Sign Structures.**

Each sign and structure shall be located according to the Plans; where necessary, for maximum effect of the sign, unless otherwise directed by the Engineer. In-

stalled signs and structures will be inspected at night for maximum effect and minimum specular reflection. If any sign exhibits specular reflection or is ineffective at night, the sign shall be adjusted at the Contractor's expense.

Signs and delineators located less than 30 feet from the pavement edge shall be erected with the sign face truly vertical and turned 93 degrees away from the center and direction of travel of the lane which the facility serves. Signs located 30 feet or more from the edge of the pavement edge shall be erected with the sign face truly vertical and aligned 90 degrees from the center and direction of travel of the lane which the offset sign serves. Special attention shall be given to the location and positioning of signs and delineators at the point where lanes divide, or on curves, to avoid specular reflection and to obtain maximum effectiveness of the facility.

B. Sign Fabrication.

1. **General.** All sign backing for flat sheet signs shall be aluminum unless noted otherwise, with reflective sheeting applied as specified herein. On large variable message signs the messages, symbols, and borders shall consist of directly applied reflective sheeting cut to desired shapes. The message, symbols and border shall be applied as specified by the sheeting manufacturer.
2. **Fabrication of Sign Backing.** Sign backing shall be cut to size and shape and shall be free of buckles, warps, dents, cockles, burrs, and all defects resulting from fabrication. Signs that are larger than manufacturer's material shall be fabricated in sections with butt joints vertical. The sections shall have a minimum width of 24 inches. If more than two sections of backing are required, the wide sections shall be placed on the outside positions and the narrower one placed in between. The widest manufacturer's sections of aluminum shall be used before narrower sections are used. The surface of all signs shall be plane surfaces.

All cutting, shearing, and drilling or punching of holes (except mounting holes for demountable letters, numerals, symbols, and borders) shall be completed before metal degreasing and application of reflective sheeting.

3. **Cleaning and Processing.** Cleaning and processing of sign backing shall take place before applying the reflective sheeting. Cleaning and processing shall be performed using the sheeting manufacturer's instructions and recommendations as well as the requirements of Section 894.

All metal sign backing material shall be handled only by handling devices or clean canvas gloves between cleaning and applying reflective sheeting. Metal shall not come in contact with greases, oils, or other contaminants before application of reflective sheeting. When backing materials are chromate-conversion coated beforehand and are allowed to set for several days before applying reflective sheeting, the application surface shall be given a solvent wipe before reflective sheeting application.

4. **Fabrication of Flat Sheet Signs.** The background of the flat sheet signs shall be screened on reflective sheeting as specified by the manufacturer of the reflective material and as specified herein. Messages, symbols, and borders may be screened on or directly applied reflective sheeting. Directly applied

reflective sheeting shall be applied as specified by the sheeting manufacturer. Colors shall meet the requirements of the Contract and as shown in the MUTCD. Care shall be taken so screening inks are compatible with reflective sheeting backgrounds.

Reflective material shall meet Section 894.02.

The reflective sheeting used on flat sheet sign backings larger than the manufacturer's material shall have reflective sheeting placed on each section with no vertical or horizontal splicing of the reflective material on the individual panels. All sheeting on each individual sign shall be from the same manufacturer's lot.

The sign face shall be processed and finished with material as specified by the sheeting manufacturer. Processing of Type III A or III B Reflective Sheeting with screened-on messages shall be accomplished before applying to the sign backing. Processing of Type II Reflective Sheeting may be accomplished before or after applying to the sign backing.

The finished signs shall have a smooth, uniform surface. All letters and numbers shall be clear cut and sharp.

5. **Fabrication of Panel Signs.** The background shall be applied to the panels as specified by the reflective sheeting manufacturer.

Reflective sheeting shall be overlap spliced. The splice shall be overlapped not less than 3/16-inch, and sheeting applied to panels shall extend over the edges and down the side legs a minimum of 1/16 inch. Splices shall be at a 90° angle to the length of the panel. The splices shall be uniformly and neatly made throughout their entire length. No individual panel shall have more than 2 splices, and the minimum distance between adjacent splices shall be 8 feet.

When guide sign symbols (e.g. handicap, hospital, and airport symbol signs) are required on larger guide signs as part of the message, the symbol signs shall be riveted to the larger signs and be installed at the locations shown on the plans. The cost of the symbol signs and the labor, equipment, and material needed to attach them will not be bid separately, but will be included in the price bid for the panel or overlay of the sign.

6. **Date of Fabrication.** All signs receiving new sign facings shall be dated with the month and year fabricated. The date shall be placed on the back of the metal backing on the lower corner of sign near the edge closest to traffic so that it can be read from the ground. The dating layout shall consist of 1/4 inch high numbers on a 2-1/4 inches long by 1-3/4 inches high pressure sensitive label. The numbers imprinted on the upper part of the label shall be 1 through 12, with the last two digits of four consecutive years printed across the bottom (as 92, 93, 94, 95). The month and year of fabrication shall be punched out. The label shall meet Section 894.04. The cost of furnishing, fabricating, and installing labels shall be included in the price bid for "Flat Sheet for Signs Type II and III A," "Panel for Signs Type II and III A," "Refacing Signs Type II and III A," or "Overlay Panel Type II and III A."

C. **Packaging, Labeling, Handling, and Shipping.**

Completed signs shall be dry before packaging or storing. Packaged signs that become wet before use shall not be used. A warning label with instructions designed

to prevent damage to the signs shall be on the outside of the package, and an additional warning label shall be placed in the packages between the first and second sign, before the last sign, and after each five signs in a package. Packaged signs shall not be banded and shall be stored and shipped on edge.

Packaging shall be done so that the signs are protected during storage, shipping, and handling. Packaged signs shall be slipsheeted using the material and methods recommended by the sheeting manufacturer.

Unmounted reflective sheeting may be stacked flat to a maximum height of 5 inches for temporary storage. Otherwise, they shall be stored on edge. The sheeting on signs shall not be exposed to temperatures above 150°F. The slip-sheeting shall be left on the sign face until mounted.

Panel signs may be assembled or separated into sections for ease in handling, storing, and shipping. In lieu of packaging, the sign faces may be turned toward each other and fastened together firmly with sufficient spacers to prevent the sign faces from touching. Sign faces that cannot be protected by packaging or fastening face to face shall have protective covers placed over them.

D. **Label (Handling, Storage, and Installation Instructions).** The label referred to in Section 754.03 C shall contain the following instructions:

1. **Loading on Vehicles.** Signs shall be secured vertically in racks to prevent them from rubbing, scratching, or marring front surfaces. Signs that have protective wrappings or slipsheeting shall be kept dry.

Signs shall be carefully unloaded, stacked on edge off the ground in an upright position.

2. **Storage at Job Site.** Signs shall be stored indoors and upright on edge to prevent damage to the reflective sheeting.

Signs shall be kept dry. Packaged signs that get wet will be rejected.

3. **Installation.**

- a. Signs shall be handled carefully and not scuffed or walked on.
- b. Nylon washers shall be used between flat washers and sign face for all Type III and IV reflective sheeted signs.
- c. When washing signs is necessary, a soft bristle brush or sponge and water shall be used.

E. **Erection of Sign Supports and Delineators.**

1. **General.** The Engineer will verify the support lengths on all new sign supports prior to the materials being ordered by the Contractor. All sign supports shall be firmly set and plumb after erection. All concrete foundations shall be constructed as specified, with the top sloped enough to drain away from the sign support. All exposed concrete above ground surface shall be given a rubbed finish. Excess excavation material removed to set sign supports shall

be disposed of at the Contractor's expense. A driving cap shall be used when driving a sign support.

2. **Delineator Posts.** Delineator posts shall be driven without being damaged. If the drilled or punched hole method is used, the hole shall be large enough so the post can be set without damage. Any damage to utilities or structures as a result of construction operations shall be repaired according to Section 105.03.
3. **Anchor for Telescoping Perforated Tubes Supports.** Anchors for telescoping perforated tubes supports shall be driven. The perforated tube anchor shall be driven to a maximum of 4 inches above the ground or sidewalk.

Anchors shall be installed at Plan length, unless the Engineer determines a shorter length is sufficient due to good soil bearing developed when driving the anchor. Anchor lengths may be reduced to a minimum of 3 feet. When set in sidewalk, the anchor plate may be omitted.

The sidewalk shall be cored to install the anchor unit and the cored area shall be filled with new concrete to restore the sidewalk surface.

4. **Single Tubular Sign Supports.** When a sign support is required, a Tubular Sign Support shall be used. Tubular Sign Supports shall be set in a Class AE Portland Cement Concrete foundation, constructed as shown on the Plans. Breakaway foundation plates shall be assembled with the bolts torqued to Plan requirements. The plates shall be carefully placed so the tapered bolt slot tapers toward approaching traffic. Either the stub post or the anchor bolt design may be used as detailed. If the anchor bolt design is used, a Portland Cement Grout shall be used to raise the top of the foundation to a snug fit under the base plate. Welders shall meet the requirements of Section 105.06 D.
5. **Overhead Sign Structures.**
 - a. **General.** All overhead sign structures shall be shop fabricated so that only bolted assembly is required in the field. Drilling to fasten an overhead sign to a bridge is permitted, but field welding is not permitted. Welders are specified in Section 105.06 D.
 - b. **Anchor Bolt Installation.** A steel template shall be used to accurately locate and hold the anchor bolts plumb and in proper alignment. This template shall be in place during placement of the concrete base and shall remain in place a minimum of 24 hours after the concrete placement has been completed. The support cage used to position the anchor bolts within the foundation shall remain in the concrete foundation. Out-of-position anchor bolts and anchor bolts greater than 1:20 out of plumb are cause for rejection of the base. Bending of the anchor bolts to straighten them or move them into position, or alteration of the base will not be permitted, and are cause for rejection of the base.
 - c. **Anchor Bolt Tightening.** The top nuts and the leveling (bottom) nuts of the anchor bolts shall be tightened as follows:
 - (1) All leveling (bottom) nuts shall be brought to full bearing on the bottom of the base plate. The bottom of the leveling nut must be kept as

close to the concrete base as practicable, and shall not be more than one inch above the top of the concrete base. Leveling nuts shall be threaded onto the anchor bolt to provide at least a 1/4 inch projection of the bolt above the top nut when in its tightened position.

- (2) Beeswax or equivalent shall be generously added to the top nut bearing face and top nut internal threads prior to placement on the anchor bolt. All nuts shall be tightened to a “snug” condition defined as the tightness attained by the full effort of a person using a wrench with a length equal to 14 times the diameter of the anchor bolt (minimum length shall be 18 inches). The full effort required to achieve a “snug” tight condition shall be applied as close to the end of the wrench as possible, and shall continue until the nut stops rotating. This is achieved by a person leaning back, pulling firmly, and using one’s entire body weight on the end of the wrench (with feet braced to prevent slipping). This snug tightening shall be accomplished in a minimum of two separate passes of tightening. The sequence of tightening in each pass shall be such that the opposite side nut, to the extent possible, shall be subsequently tightened until all the nuts in that pass have been snugged.

“Snug” tightness of the nut shall be checked in the presence of Department personnel after the Contractor has completed nut snugging as described above but prior to commencing step (4) below. “Snug” tightness of the nuts (top and leveling) shall be checked by applying a torque to the nut according to the following values:

Bolt Diameter (inches)	Torque (foot-pounds)
1	100
1-1/4	200
1-1/2	300
1-3/4	400
2	500
2-1/4	700
2-1/2	800

- (3) After Step (2) has been completed, the top nut and leveling nut must be in full bearing on the base plate. If any gap exists between either nut (top or leveling) and the base plate, a beveled washer shall be inserted between the nut washer and the base plate to eliminate the gap. The washer shall be stainless steel Type 304, shall be the same diameter as the hardened washer, and shall be so beveled that the gap between the nut and the base plate is eliminated. All nuts shall be retightened according to Step (1) and (2) above if beveled washers are added. All costs required to remove and re-erect this structure to install beveled stainless steel washers shall be at the Contractor’s expense.
- (4) All top nuts shall be tightened an additional 1/3 turn by use of a hydraulic wrench. All of the nuts shall be tightened in two separate passes of equal incremental turns (1/6 turn each pass). The sequence

of tightening in each pass shall be such that the opposite side nut, if possible, shall be subsequently tightened until all the nuts in that pass have been turned. There shall be no rotation of the leveling nut during top nut tightening.

- (5) Tightness of the nuts shall be checked in the presence of Department personnel a minimum of 48 hours after the nuts have been rotated the additional 1/3 turn. Tightness of the nuts shall be checked by applying a torque to the nut in accordance with the following values:

Bolt Diameter (inches)	Torque (foot-pounds)
1	300
1-1/4	630
1-1/2	1,120
1-3/4	1,820
2	2,770
2-1/4	4,010
2-1/2	5,550

After the anchor bolt nuts have been checked for tightness, ultrasonic testing, and calibration procedures will be performed by the Department for final acceptance. This is to assure that no flaws in the bolts have been introduced during the construction process and no loose nuts or washers exist.

The Engineer will tap each nut (top and leveling) with a 24-ounce ball peen hammer to check for looseness. A tight nut produces a sharp ringing sound, and a loose nut produces a dull sound. The Engineer will tap each washer on one side while placing one hand on the other side of the washer. If the washer moves, the nut is not properly tightened. A wrench with a length equal to 14 times the diameter of the anchor bolt (minimum 18 inches) will be used by the Engineer to check the tightness of each nut. If a nut rotates as a result of the application of a person's full effort on the end of the wrench, the nut is not properly tightened. If any nut or washer is found loose as a result of the above acceptance procedure by the Engineer, the Contractor shall tighten such loose nuts according to Steps (1) through (5) above. The Engineer will determine the extent of removal, disassembly, and re-erection of the structure. If any nuts require tightening after the initial installation, all costs required to remove and reinstall nuts and washers and, if necessary, to remove and re-erect the entire structure shall be at the Contractor's expense.

The Contractor must test to verify the absence of flaws prior to the erection stage. Reflectors found with an indication rating less than 15 decibels will be cause for rejection of the entire base installation. Replacement of the base installation shall be done at the Contractor's expense.

- d. **Erection Procedures.** Erection of the overhead sign supports shall be done according to the sequence indicated below. Traffic shall be maintained during erection according to Plans and Specifications.
- (1) Bottom leveling nuts and washers shall be placed on all the anchor bolts. These nuts shall initially be placed 1/4 inch above the concrete

foundation. The nuts shall then be brought into level with the highest nut above the foundation. Clearance between the concrete foundation and the bottom leveling nuts shall not exceed 1 inch maximum.

- (2) The column only, without the truss or arm brackets attached, shall be placed on the leveled bottom nuts and washers.
- (3) Beeswax or the equivalent shall be applied to all top nut bearing faces and the top nut internal threads prior to placement on the anchor bolt. The two top nuts perpendicular and the two top nuts parallel to the sign face (in its final position) shall be placed on the anchor bolts, along with their corresponding washers, and snug tightened.
- (4) The column base plate shall be leveled by adjusting only the nuts perpendicular and parallel to the sign face (in its final position).
- (5) Remaining top nuts and washers shall be placed on the on the anchor bolts and loosely snug tightened.
- (6) All bottom and top nuts shall now be tightened according to Sections 754.03 E.5.c(1) through 754.03 E.5.c(4) above.
- (7) The assembled arm bracket or truss, without the sign, shall be placed on the erected column. All bolts shall be tightened by the turn-of-nut method specified in Section 616.03 C.3.c(1) Table 2 of the Standard Specifications. Any nuts and bolts loosened or removed after being fully tightened shall not be reused. Previously tightened bolts that have been loosened by the tightening of adjacent bolts will not be considered as reused and may be retightened.
- (8) The sign panel shall be placed on the erected arm bracket or truss.
- (9) The anchor bolt nuts connecting the column base to the concrete foundation shall now be checked for tightness according to Section 754.03 E.5.c(5) above.

6. **W-Shaped Sign Supports.**

- a. The Contractor shall install H-Pile footings for W-Shaped Sign Supports constructed as shown on the Plans. Breakaway base plates shall be assembled with the bolt torqued to Plan requirements. The plates shall be carefully placed so the tapered bolt slot tapers toward approaching traffic.
- b. **Flame Cutting of W-Shape Posts.** The gas cutting torch may be used for cutting metals or preparing joints. Carbon steel above 0.30 percent carbon, high alloy steels, heat treated steel, and plated metals shall not be flame cut unless subsequent corrective treatment is provided as approved by the Materials and Research Engineer.

All flame cutting work shall be done by the oxyacetylene gas method or other method approved by the Engineer. The maximum permissible

deviation from true lines shall be 1/16 inch. Repairs of edge defects shall be done according to Section 3.2 of AWS Structural Welding Code, as amended by AASHTO Specifications for Welding of Structural Steel Highway Bridges. In general, the roughness of flame cut surfaces shall be no greater than an ANSI roughness value of 1,000 microinches. All slag from flame cutting shall be completely removed.

When flange plates or other members are cut to a curve, the curve shall be uniform to the radius required. A series of straight cuts tangent to the curve shall not be acceptable.

When ends of members, which are to take bearing, are cut with a torch a suitable allowance in their length shall be made to permit proper milling or planing.

Joints for welding may be prepared by "flame cutting" or "flame gouging" provided all slag and oxidized metals are removed.

- c. **Edge Finishing.** Members formed to specific size by shearing of structural steel plates having a thickness of 1/2 inch or more, shall be machined or planed to correct size by removing not less than 1/4 inch of metal. All field splice plates and stiffeners less than 1/2 inch in thickness shall have a minimum of 1/8 inch of metal removed by machining or planing after shearing.
- d. Welding applications as specified in Section 105.06 D.

F. **Mounting Flat Sheet Signs Type III A and III B Sheeting.** Flat sheet signs shall be bolted to the supports and shall have a nylon washer between the flat washer and the sign face. Rubber incased washers may be substituted for nylon washers on work zone traffic control signs specified under Section 704.

G. **Removing and Resetting Signs and Supports.** Existing signs and supports shall be removed and reset as specified. All signs and supports not to be reset shall be stockpiled on the Project Right of Way at designated locations. The stockpiled signs and supports shall remain the Department's property.

Removed or reset signs and supports that become damaged during removing, resetting, or stockpiling shall be replaced at the Contractor's expense.

Existing signs and supports shall be removed as construction progresses, and shall be immediately reset or installed. The Contractor shall install new signs or reset signs as shown on the Plans. All signs and supports shall be on the Project site at the time construction begins. The Contractor may choose to temporarily reset existing signs, or temporarily install new signs. The cost of installing and resetting signs temporarily shall be included in the price bid for other items. Any damaged signs or supports shall be replaced at the Contractor's expense.

H. **Remove Sign Foundations.** This item consists of removing signs, steel supports, and foundations or H-pile footings and restoring the surface to match the surrounding area. Foundations and H-pile footings shall be removed to a depth of 2 feet below the ground line unless otherwise specified in the plans. The signs, steel supports, H-pile footings and foundations removed shall become property of the Contractor and be disposed of outside the highway Right of Way.

- I. **Revise Fuse Joints.** This item consists of removing the existing front fuse plate and back hinge plate and installing a new front perforated fuse plate and a new back hinge plate as shown on the detail sheets in the Plans. All nuts will be tightened securely, torquing is not required.
- J. **Overlay Panel Sign Refacing.** This item consists of removing the legend, border, and symbol on those signs that have demountable copy and place overlay panels on the signs. Those signs that have direct applied reflective sheeting legends, borders, and symbols need not have these removed. The new changed legends, borders, and symbols shall be direct applied to the thin metal overlay panels and installed on the existing signs. The legends, borders, and symbols are deemed not salvageable and shall be disposed of by the Contractor outside the highway Right of Way.

The overlay panels shall be fabricated from 0.063 inch aluminum alloy conforming to ASTM B 209 alloy 6061-T6 or 5052-H38 with mill finish. The overlay panels shall be fabricated according to Section 894.01 and degreased, etched, and coated according to Section 894.01 of these Specifications.

The reflective sheeting applied to the overlay panels shall meet the requirements of Section 894.02 of these Specifications.

The letters, numerals, symbols, and borders shall be directly applied according to Section 894.04. The Reflective sheeting shall meet the requirements of Section 894.02. Type IIIA reflective sheeting letters, numerals, symbols, and borders shall be used on Type II background. Type IIIA reflective sheeting letters, numerals, symbols, and borders shall be used on Type IIIA background. The overlay panels, after fabrication, shall be installed on the existing signs with aluminum blind fasteners 5/32 inch diameter with 1/8 inch out the back of the existing sign backing or other non-corrosive fasteners approved by the Engineer. The panels are to be butted together with no overlap. Where legends, numerals, symbols, and borders cross the butt joints, they will need to be cut.

Signs that are to be overlaid that are larger than manufactured overlay panels shall be fabricated as follows: Overlay panels shall be a minimum of 18 inches wide and a maximum of 4 feet wide. Panels will have a minimum length of 8 feet. If the overlay panels do not cover the full height of the sign, the overlay panels shall be placed on the lower portion of the sign first so the longer side of the panel is vertical. The remaining panels shall be placed above these panels with their long side placed horizontally. The overlay panels shall be riveted around the panel with the rivets 1 inch from the edge of the panel. The rivets shall be evenly spaced with no more than 12 inches between rivets, horizontally and vertically. Panels more than 24 inches wide shall be riveted down the middle of the panel at 12-inch centers.

- K. **Auxiliary Signs.** The auxiliary signs used with route markers shall be the same background color as the route markers they are used with. (Interstate - Blue, State - White, Interstate Business Loop - Green, and County - Blue.)

754.04 METHOD OF MEASUREMENT.

- A. **Flat Sheets, Panels, and Extruded Aluminum Panels.** Flat sheets, panels, and extruded aluminum panels for signs will be measured to the closest 1/10 square

foot, complete, in place, and accepted by the Engineer. All hardware, stringers, and brackets required to attach signs to the posts shall be included in the pay item.

B. Galvanized Steel Posts.

1. **Galvanized Steel Posts - Telescoping Tube.** Telescoping Tube posts will be measured by the linear foot, complete, in place and accepted by the Engineer. All sizes will be measured and paid for as "Galvanized Steel Posts - Telescoping Perforated Tube."

The post length shall be measured from the top of the post to bottom of post and top of anchor to the bottom of the anchor, as shown on the Plans. The sleeves and break away base, if included, will not be measured for payment, but shall be included in the bid item "Galvanized Steel Post." The Pulley Winch, Pulleys, Cable, Fabricated Plates, Perforated Tubes and hardware shall be included in the price bid for "Galvanized Steel Posts - Telescoping Perforated Tube."

2. **Galvanized Steel Posts - Standard Pipe.** Pipe post signs will be measured by the linear foot of each size installed and accepted by the Engineer. The post length shall be measured from the top of the breakaway base to the top of the post, as shown on the Plans. The concrete base will be paid for separately. The Pulley Winch, Pulleys, Cable, Fabricated Plates, Perforated Tubes and hardware shall be included in the price bid for "Galvanized Steel Posts - Standard Pipe."

3. **Galvanized Steel Posts - W-shaped Posts (two or more).** W-shaped posts will be measured by the linear foot of each size installed and accepted by the Engineer. The post length, the 12-foot driven pile length, and the 2-foot stub post, as shown on the Plans, will be included in the length of post to be measured and paid for. The Wind Beams and Anchor Plates shall be included in the price bid for "Galvanized Steel Posts - Telescoping Perforated Tube." The Pulley Winch, Pulleys, Cable, Fabricated Plates, Perforated Tubes and hardware shall be included in the price bid for "Galvanized Steel Posts - W-shaped Posts." The post length and the 14-foot pile length as shown in the Plans, will be included in the length of the post to be measured and paid for.

- C. **Breakaway Bases.** Breakaway bases for standard pipe, W-shape, and telescoping tubes will not be measured, and all hardware, stub posts, slip bases, and assembly will not be measured but shall be included in the bid item "Galvanized Steel Post."

- D. **Delineators.** The quantity will be measured by the number of delineators of each type installed, complete with reflectors.

- E. **Concrete Foundation.** When concrete foundations are used on single post signs, the concrete will be measured by the cubic yard based on the quantity shown for each foundation complete, in place, and accepted by the Engineer. Reinforcing steel will not be measured but shall be included in the price bid for concrete.

The splices, post caps, plates, bolts, cutting fuse joints, and assembly will not be measured but shall be included in the bid item "Galvanized Steel Post."

- F. **Overhead Sign Structure, Various Truss Lengths.** Overhead sign structures' truss lengths as specified will be measured by the number of structures of each

length complete in place. The inspection walk (mounting hardware, grating, handrail, etc.) and hardware required for attaching of the inspection walk and assembling the structure shall be included in the price bid to perform this work.

- G. **Overhead Sign Structures on Bridges.** Overhead sign structures on bridges will be measured by the number of structures in place. All hardware, supporting structures attached to the bridge, inspection walk, and sign supporting structures shall be included in the price bid to perform this work. The anchor bolts, nuts, washers, and tightening as specified herein will not be paid for separately but shall be included in the price bid "Class AE Concrete - Sign Foundations."
- H. **Reset Sign Panels.** The quantity to be paid for will be measured by the number of locations at which a sign, or a sign assembly, has been reset. Signs and assemblies will be measured in place and accepted by the Engineer.
- I. **Reset Sign Supports.** The quantity to be paid for will be measured by the number of supports installed, complete, and accepted by the Engineer.
- J. **Removed Signs and Supports.** Removed signs and supports will not be measured for payment, but will be included in other bid items. Cost of removal shall be included in the price bid for other items.
- K. **Remove Sign Foundations.** The item "Remove Sign Foundations" will be measured by the number of foundations and H-piling footings removed. The quantities measured will be paid for at the Contract Unit Price, and will be full compensation for all labor, equipment, and material necessary to complete the removal and disposal.
- L. **Revise Fuse Joint.** The item "Revise Fuse Joint" will be measured by the number of fuse joints revised. The quantities measured will be paid for at the Contract Unit Price and will be full compensation for all labor, equipment, and material necessary to complete the work.
- M. **Overlay Panel.** The item "Overlay Panel" will be measured by the square foot of panel in place and accepted by the Engineer. The quantities measured will be paid for at the Contract Unit Price and shall include all labor, equipment, and material needed to complete the work.
- N. **Reset Mile Post.** The item "Reset Mile Post" will be measured by the number of locations at which a mile post has been reset. The quantities measured will be paid for at the contract price and shall be full compensation for all labor, equipment, and material necessary to complete the work.

754.05 BASIS OF PAYMENT.

Payment will be made at Contract Unit Prices for the following:

Pay Item	Pay Unit
Flat Sheet for Signs, Type II, III A, or III B Reflective Sheeting	Square Foot
Panel for Signs - Type II, III A, or III B Reflective Sheeting	Square Foot
Extruded Aluminum Sign Panels Type III A, and III B Reflective Sheeting	Square Foot
Delineators, Type A, B, C, D, or E	Each
Class AE Concrete - Sign Foundations	Cubic Yard
Overhead Sign Structure, Various Truss Lengths	Each
Overhead Sign Structure on Bridges	Each
Reset Sign Panels	Each
Reset Sign Supports	Each
Galvanized Steel Posts - Telescoping Perforated Tube	Linear Foot
__ Inch Galvanized Steel Post - Standard Pipe	Linear Foot
__ Inch Galvanized Steel Posts - W-Shaped (two or more)	Linear Foot
Remove Sign Foundations	Each
Revise Fuse Joint	Each
Overlay Panel	Square Foot
Reset Mile Post	Each

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

SECTION 762 PAVEMENT MARKING

762.01 DESCRIPTION.

This work consists of furnishing and installing specified pavement markings at the designated locations.

762.02 MATERIALS.

Pavement Marking material shall meet the following:

Item	Section
Pavement Marking Paint*	880.01
Glass Beads for Pavement Marking Paint	880.02
Plastic Pavement Marking Film*	880.03
Preformed Plastic Marking Film	880.04
Preformed Patterned Pavement Marking Film	880.05
Short-Term Pavement Marking	

Paint	880.06
Tape	880.06
Construction Zone Marking	880.07
Raised Pavement Markers	880.08
Epoxy Paint Pavement Marking	880.09

*Either "slow," "medium," or "fast dry" paint and either type of Plastic Marking Film may be used.

762.03 EQUIPMENT.

- A. Paint Applicator.** The equipment required to apply pavement marking paint and glass beads shall be a self-propelled, pneumatic spraying machine with atomizing nozzles capable of applying two 4-inch to 8-inch wide lines at one time. The spray mechanism shall be operated by quick opening and closing valves. The applicator shall apply the materials at a rate specified in an even and uniform thickness with clearly defined edges. The applicator shall have reservoirs or tanks equipped with agitators that keep the material in a smooth, even mixture. Tanks shall have sufficient capacity to apply the materials as specified. The applicator shall be equipped with an automatic skip control device that applies a stripe of specified length with a linear tolerance of 3 inches. The applicator shall be equipped with a guide boom and be capable of retracing and applying materials to traffic markings in place.

Adequate hand-operated equipment shall be required to place the pavement markings on areas not readily accessible to the pavement marking applicator.

The machine shall be equipped with a glass bead dispenser adjusted and synchronized with the paint applicator to distribute the reflectorizing spheres uniformly on the painted line(s) using air pressure. The bead dispenser shall be equipped with an automatic cutoff control, synchronized with the cutoff of the striping material.

- B. Grooving Equipment.** The grooving equipment shall utilize diamond blades mounted on a self propelled machine designed for grinding a recess into the pavement surface. The diamond blades shall be gang mounted on a floating head with controls capable of providing uniform depth and alignment. The grooving equipment shall be capable of grooving a total width sufficient to install 4-inch wide pavement marking tape in a single pass. The equipment shall not cause strain or damage to the underlying surface of the pavement. Grooving equipment that causes ravels, aggregate fractures, spalling, or disturbance of the joints shall not be permitted.

762.04 CONSTRUCTION REQUIREMENTS.

- A. General.** A project layout of the pavement striping and marking shall be prepared and submitted to the Engineer for approval 48 hours before any installation work. Type F paint shall be used for all painted centerline pavement marking, other than short-term pavement marking.
- B. Pavement Surface Preparation.**
- General.** The pavement surface in the area where markings are to be applied shall be clean and dry. Foreign materials, (i.e., dirt, petroleum products, paint, and curing compound) shall be removed from the pavement surface before

applying pavement marking. The amount of pavement moisture shall be tested by taping a 12-inch by 12-inch (approximate) sheet of transparent plastic film, similar to "Saran Wrap," to the pavement. If moisture condenses on the pavement side of the film within 15 minutes, the pavement must be dried before installing pavement markings. The moisture test will not be required when water-based pavement marking paint is used.

2. **Plastic Pavement Marking Film.** The pavement surface shall be cleaned by sandblasting, power water spray, grinding, wire brushing, brooming, compressed air, or other methods to the satisfaction of the Engineer. New Portland Cement concrete that has curing compound on it shall be sandblasted. Costs associated with the required cleaning shall be included in the bid item "Plastic Pavement Marking Film." If short-term or permanent pavement marking is encountered, removal will be paid for at the Contract Unit Price bid for Obliteration of Pavement Marking. When no bid item is provided, the cost of removing the pavement marking will be paid for under Section 104.03.
3. **Preformed Patterned Pavement Marking Film.** The preformed marking shall be capable of being adhered to asphalt concrete by a pre-coated pressure sensitive adhesive. A primer may be used to precondition the pavement surface.
4. **Pavement Marking Paint.** If the Engineer requires a cleaning method other than air pressure, the cost of cleaning will be paid for under Section 104.03.
5. **Short-Term Pavement Marking.** Short-term pavement marking shall be an application of pavement marking paint, pavement marking tape, or raised pavement markers. The surface preparation for application of the short-term pavement marking shall be the same as that required for permanent striping.
6. **Grooved Pavement Markings.** When specified in the Plans, the pavement surface shall be grooved to make a recess in the pavement surface for the pavement marking film. The groove shall meet the following tolerances:

Depth	100 mils \pm 10 mils
Smoothness	ridges, within the groove, be no more than 6 mils higher than either adjacent valley
Width	line width plus 1/2 inch
Length	line length plus 3 inches per end of line
Line End Tapers	3 inches

For messages, the area grooved shall be the same area as the messages. Grooving a rectangular area to contain the message will not be allowed. Grooving shall meet the depth requirements specified above.

After grinding, the grooved slot shall be blown clean to remove any residue and loose materials prior to the installation of the pavement marking. When wet-grinding, the grooved slot shall immediately be pressure washed to remove residue. If necessary, the grooved slot shall be blown clean just ahead of

the pavement marking installation. The pavement markings shall be installed on a clean dry surface within 24 hours of the initial grinding. If pavement marking installation does not occur within 24 hours of the initial grinding, the groove shall be sandblasted and blown clean to remove any dirt, oil, loose material, or other contaminate prior to the installation of the pavement marking.

The pavement marking film shall be installed as specified in Section 762.04 D.

C. **Traffic Control.**

1. **Signing.** The Contractor shall erect and maintain sufficient devices (cones, signs, barricades) to protect the work area from traffic interference, tracking on or damage to the cleaned pavement, and the newly applied markings. All devices used to divert traffic from the work zone shall be designed to resist displacement by wind.
2. **Traffic Movement.** Traffic shall be maintained through the work area at all times according to the traffic control plan and Section 704. Flagpersons shall be furnished when required.

Two-way traffic shall be maintained on two-lane roadways, and 1/2 of the roadway shall be open to traffic on multi-laned roadways at all times. The cost to furnish, erect, and maintain cones, signs, and barricades including the cost for flagging and shadow vehicles, shall be included in the cost of pavement marking.

PROTECTION VEHICLE WITH TRUCK MOUNTED ATTENUATION DEVICE (TMA):

A protection (shadow) vehicle with a truck mounted attenuation device shall be provided by the contractor to protect personnel and equipment from damage during mobile operations. The protection (shadow) vehicle will not be required on construction projects when the advance warning signs are in place.

Truck-mounted attenuation device shall meet the test requirements of NCHRP Report 350 test level TL-3.

The protection vehicle equipped with the TMA shall have a minimum weight of 10,000 pounds or the minimum weight recommended by the manufacturer of the TMA.

The protection vehicle shall be equipped with seat and shoulder belts along with a head cushion.

The protection vehicle shall have an advance warning flashing or sequencing arrow panel conforming to Section 704.02 M and the *Manual on Uniform Traffic Control Devices*.

The positioning of the protection vehicle with the TMA in relation to construction activities will be as shown in the Plans.

The cost of furnishing the protection vehicle with the TMA shall not be bid separately, but shall be included in the price bid for the item "Pavement Markings."

3. **Time Period for Control.** Necessary traffic control devices shall be properly placed and in operation before construction is allowed to start. The devices shall be kept current and placed only in the areas of actual work activities. Traffic control devices shall be kept in place until the Engineer approves their removal after the pavement marking has dried, and is determined to be ready for traffic.
4. **Operational Precautions.** Equipment shall not be prepared, filled, or cleaned, nor shall any equipment or material be stored on the roadway. These operations shall be conducted off the pavement without interfering with or endangering traffic according to Section 107.05 A.

D. Pavement Marking Application.

1. Pavement Marking Paint and Glass Beads.

- a. **Method of Application.** Pavement marking paint and glass beads shall be applied separately by machine. Where machine application in an odd-shaped area is not feasible, hand application is permitted.
- b. **Application Dates and Temperatures.** Pavement marking paint and beads (except for temporary stripe) shall not be applied before May 1 nor after October 1 except upon written permission of the Engineer. Pavement marking paint shall be applied only during daylight hours when the air and pavement surface temperatures are 40°F. or warmer when applying solvent based paint or 45°F. or warmer when applying water based paint. The paint shall not be applied when the air and pavement surface temperatures are expected or forecasted to be colder (lower) than the minimum application temperature.

New asphalt pavement shall be allowed to cool to a maximum temperature of 125°F. and be given a minimum curing period of four hours prior to applying permanent striping.

- c. **Rate of Application.** One gallon of paint shall cover a 4-inch wide stripe for a length of 280 to 320 feet, depending upon pavement surface texture. Short-term pavement markings shall have a thickness of 8 mils wet when permanent marking is epoxy paint. The paint shall not be diluted, but a small amount of naphtha thinner may be used to flush out paint containers. Glass beads shall be evenly distributed over the wet paint stripe at a rate of at least 6 pounds per gallon of paint. Beads shall be applied using an automatic pressure dispenser. If the application rates are not within the requirements, the marking application shall be stopped until corrections are made.
- d. **Short-Term Pavement Marking.** Pavement marking paint and beads applied as short-term pavement marking shall be applied only during daylight hours. Application shall be made in a 4-inch width and a 10-foot length with unpainted gaps of 30 feet. The no-passing zone markings shall be made in a 4-inch width and a length as required to cover the no-passing zones. The paint and beads shall be applied as required and at the rate specified in Section 762.04 D.1.c. Short-term pavement marking applied to the center line shall be applied to the full length of the bitumi-

nous course and milled surface before sunset on the same day the work is accomplished. Paving or milling operations shall not resume if the short-term pavement marking has not been replaced as required.

On the final lift, new asphalt pavements shall be allowed to cool to a maximum temperature of 125°F. before applying short-term pavement marking paint.

Short-term pavement marking on the top lift shall be carefully placed with exact alignment and spacing so that the permanent striping will match when applied. Errors in alignment and spacing shall be corrected at the Contractor's expense, or removed just before the installation of the permanent striping.

When Type NR (Not Easily Removable) short-term pavement marking is specified, pavement marking paint and beads may be used in lieu of Type NR construction zone marking film.

- e. **Short-Term Pavement Marking - Seal Coat Projects.** Short-term pavement marking for seal coat projects shall consist of pavement marking paint and beads. Before sealing operations, spotting tabs shall be installed every 200 feet along the centerline and tabs shall also be placed to mark the beginning and end of the no-passing zones. The spotting tabs shall be removed by cutting the tabs flush with the roadway surface. Tabs shall not be pulled out. The cost of the spotting tabs and their installation and removal shall be included in the bid item "Short-Term Pavement Marking."

The short-term pavement marking shall be applied before sunset each day to the full length of the roadway that received the bitumen and cover coat material that day. Seal coat operations shall not resume if the short-term pavement marking is not in place as required. The broken line at centerline of two-lane, two-way roadways (yellow) or between lanes of multi-laned roadways (white) shall be 4 inches wide and 10 feet long followed by a 30-foot unpainted gap. The solid line barrier stripe (yellow) in no-passing zones shall be 4 inches wide, and the length shall be that required to cover the entire no-passing zone. Before applying the paint and beads, the areas to receive the striping shall be lightly broomed.

If the in-place short-term pavement marking has become obscured and has lost its required visibility due to being covered, or partially covered, by cover coat or blotter material, the material shall be removed from the striped areas by light brooming or compressed air before sunset. Damage to the cover coat material and striping resulting from the removal operation shall be corrected at the Contractor's expense.

The short-term pavement marking shall be carefully placed with exact alignment and spacing so that the permanent striping matches when applied. Errors in alignment and spacing shall be corrected at the Contractor's expense.

One gallon of paint shall cover a 4-inch wide stripe for a length of 200 to 240 feet, as directed by the Engineer. Glass beads shall be evenly distributed over the wet paint at the rate of at least 6 pounds per gallon of paint.

f. **Tolerances.**

- (1) The length of the painted stripe shall not vary more than plus or minus 3 inches from the prescribed length.
- (2) The width of the painted stripe shall not vary more than plus or minus 1/2 inch from the prescribed width.
- (3) The length of the painted segment and gap shall not vary more than 6 inches in a 40-foot cycle.
- (4) The tolerance from the proper alignment shall not vary more than plus or minus 2 inches.
- (5) Dashed lines that are painted over existing dashed lines shall begin within 6 inches of the beginning of the existing line, unless otherwise directed by the Engineer.

2. **Plastic Pavement Marking Film.**

- a. **General.** Plastic pavement marking film applied as a permanent pavement marking shall not be applied before June 1 nor after September 1 of any year. The permanent marking film shall not be applied when the pavement surface temperature is 50°F. or colder, nor shall the film be placed over painted markings. The pavement surface and the marking film shall be prepared for installation as required for the type of film used. The film shall be lap or butt spliced when required to join two lengths of film, and the film shall be cut at open joints or cracks in the pavement. The cut ends shall be firmly tamped in place.
- b. **Plastic Pavement Marking Film Application.** Application of plastic pavement marking film, whether by contact cement or mechanical application, shall be made using the manufacturer's recommendation.
- c. **Plastic Pavement Marking Film Rolled in Hot Asphalt.** The plastic pavement marking shall be rolled into the hot asphalt surface. The contractor shall arrange to have the plastic pavement markings placed on the hot asphalt in the position shown on the plans at the time of final asphalt rolling operations. The plastic pavement markings shall receive at least one rolling. The requirements not allowing installation prior to June 1 or after September 1 will not apply. The temperature of the hot asphalt pavement during application shall be as specified by the manufacturer. The cost of placing and rolling the pavement markings into the hot asphalt pavement shall be included in the price bid for the item "Plastic Pavement Marking Film Line or Message."
- d. **Short-Term Pavement Marking.** Pavement marking tape applied as short-term pavement marking shall conform with the requirement for application of pavement marking tape. The tape shall be applied on the center line in a 4-inch width and a 10-foot length with a gap of 30 feet. Short Term Type R and Short Term Type R-WR shall be installed where air and pavement temperatures are 50°F and are expected to remain at or continue to increase above 50°F. If either temperature falls below 50°F,

short-term paint shall be substituted and paid for as “Short Term__IN Line - Type NR.” Removal of the paint will be paid for as “Obliteration of Pvmt Mk.” The short-term paint substitution shall cease and installation of “Short Term__IN Line - Type NR” shall proceed as soon as air and pavement temperatures reach 50°F. The no-passing zone markings shall be made in a 4-inch width and a length, as required, to cover the no-passing zone. The short-term pavement marking shall be applied to the full length of the bituminous pavement and milled surface placed each day, and shall be completed before sunset each day. Paving and milling operations shall not resume if the striping is not in place as required.

Type R-Removal Retroreflective Film, Type R-WR-Removable Wet Reflective Film, and Type NR Retroreflective Pavement Striping (not easily removed) construction zone marking film shall be applied where specified. The film required shall be applied as specified for pavement marking film.

The Contractor shall remove the Type R or Type R-WR construction zone marking film when required in the Contract or directed by the Engineer.

Pavement marking paint with beads may be used in lieu of Type NR construction zone marking film for short-term pavement marking.

3. **Preformed Patterned Pavement Marking Film.**

- a. **General.** Preformed Patterned pavement marking film applied as a permanent pavement marking shall not be applied before June 1 nor after September 1 of any year. The permanent marking film shall not be applied when the pavement surface temperature is 50°F. or colder, nor shall the film be placed over painted markings. The pavement surface shall be prepared for installation as required by the manufacturer. The film shall be lap or butt spliced when required to join two lengths of film, and the film shall be cut at open joints or cracks in the pavement. The cut ends shall be firmly tamped in place.
- b. **Preformed Patterned Pavement Marking Film Application.** Application of preformed patterned pavement marking film shall be according to the manufacturer’s recommendation.
- c. **Preformed Patterned Pavement Marking Film Rolled in Hot Asphalt.** The Contractor shall provide Preformed Patterned Pavement Marking Film for longitudinal lines and messages. The preformed patterned pavement marking shall be rolled into the hot asphalt surface. The Contractor shall arrange to have the preformed patterned pavement markings placed on the hot asphalt in the position shown on the plans at the time of the final rolling operations. The preformed patterned pavement markings shall be rolled at least twice. The requirements not allowing installation prior to June 1 or after September 1 will not apply. The temperature of the hot asphalt pavement during application shall be as specified by the manufacturer. The cost of placing and rolling the pavement markings into the hot asphalt pavement shall be included in the

price bid for the item “Preformed Patterned Pavement Marking Line or Message.”

4. **Pavement Marking Sheeting (Pressure Sensitive).** This marking shall be applied as required in the Contract or by hand or mechanical methods to a pavement surface prepared as required for all pavement marking. The delineated position on the pavement surface shall be primed using the sheeting manufacturer’s recommendations. The primed surface shall be air dried for one to two minutes before applying the sheeting. Mechanical application conforming to the sheeting manufacturer’s recommendations shall be used, unless machine application is impractical. Sheeting shall be inlaid into the pavement by roller when the pavement is warm enough to accept the pavement marking sheeting without damaging the sheeting.
5. **Raised Pavement Markers.** Raised pavement markers shall be reflectorized. Broken lane lines and center lines on two-lane two-way roadways shall consist of four markers on 3.33-foot centers with a 30-foot gap. Markers used for solid lines shall be spaced on 5-foot centers. Raised pavement markers used in double solid lines shall be placed side by side separated by a 4-inch gap.

New concrete pavement (pavement that has had no traffic over it for a winter season) shall have markers placed on 5-foot centers for all solid lines.

6. **Epoxy Paint and Glass Beads.**

- a. **Description.** The work shall consist of furnishing and installing reflectorized white and yellow two-component, 100 percent solids epoxy pavement markings. Applications are lines, legends, symbols, crosswalks and stop lines placed in accordance with the Plans or as directed by the Engineer. Upon curing, the materials produce pavement markings of specified thickness, width and retroreflectivity that resist wear from high traffic volumes for several years. During darkness and weather permitting, yellow markings shall be readily distinguishable from white markings.
- b. **General.** Pavement markings shall be placed in accordance with the details shown in the Plans and the control points established by the Engineer.

Pavement surfaces, upon which epoxy markings are to be applied, shall be cleaned as per the manufacturer’s recommendation at the discretion of the Engineer.

New Portland Cement Concrete surfaces and existing pavement markings shall be cleaned by sandblasting, shotblasting, grinding, or waterblasting to remove all surface treatments, laitance, or existing pavement markings to the satisfaction of the Engineer and manufacturer’s recommendations.

Bituminous seal coats must be completely cured and free of loose aggregate. All pavements shall be brushed with a rotary broom (nonmetallic). Additional cleaning may be required to provide a surface that is free of oil, grease, mud, dirt, existing markings that may be loose, dust, and other deleterious material prior to the application of the epoxy markings.

Existing epoxy pavement markings shall be sandblasted, shotblasted, or ground to remove a sufficient amount of the existing epoxy marking to provide a clean, rough surface for the application of new epoxy markings.

When permanent pavement markings are to be epoxy paint, and short-term pavement marking paint is used, the paint shall be applied at a rate of 10 mils. Glass beads shall be applied at a rate of 6 pounds/gallon. removal of the 10 mils layer of short-term pavement markings shall not be required prior to placing the epoxy paint.

If the roadway surface is dry, the epoxy material application shall immediately follow the pavement cleaning and be preceded by an air blast. However, markings shall not be applied when the wind or other conditions cause a film of dust to be deposited on the pavement surface before the material can be applied.

The Engineer will place necessary spotting at appropriate points as overall horizontal control for striping and to indicate necessary starting and cutoff points. Broken line intervals will not be marked. Longitudinal joints, pavement edges, and existing markings shall serve as control points when so directed.

The epoxy pavement marking material will be applied at a thickness of 20 mils on new concrete surfaces and 20 mils on new asphalt surfaces (calculated without drop on glass beads). The minimum line width shall be its nominal width with 1/4 inch greater than the nominal width allowed provided the variation is gradual and does not detract from the general appearance. Broken line segments, normally 10 feet every 40 feet, may vary up to 3 inches from the specified lengths provided the over and under variations are reasonably compensatory. Alignment deviations from the control guide shall not exceed 2 inches, except when approved by the Engineer. Material shall not be applied over a longitudinal joint. Establishment of application tolerances shall not relieve the Contractor of his responsibility to comply as closely as practicable with the planned dimensions.

- c. **Spraying Operation.** Placement of epoxy materials shall be permitted only on a clean, dry pavement surface and air and pavement temperatures at least 50°F. A lower temperature may be allowed if the manufacturer, in writing, approves a lower temperature and warrants the adhesion of the epoxy to the pavement for a minimum of one year.

Glass beads shall be applied immediately after the placement of the epoxy. The dispenser system must deliver at least 25 pounds of beads per gallon of epoxy material. The Contractor shall cooperate with inspection personnel in reviewing operation of the equipment, safety precautions, measurement of materials (components and beads), computations to determine epoxy thickness, and notifications as to work schedule.

Type II epoxy material shall be used for epoxy pavement markings except when Type I is specified on the Plans.

Traffic control for the pavement marking operations shall be in substantial conformance with the MUTCD. A shadow vehicle with a truck-mounted attenuator shall be used on high speed [SPEED LIMIT (40 mph) and greater], high volume (ADT 1,500 and greater) highways.

E. Inspection and Acceptance.

1. **General.** Markings that are discolored, damaged by wind-blown dirt, or are ineffective at night will be rejected. Unsightly markings with uneven edge lines, poor longitudinal alignment, uneven adherence, missing portions, or other objectionable faults will be rejected. All rejected markings shall be repaired, or removed and replaced at the Contractor’s expense.
2. **Maintenance of Short-Term Pavement Markings.** Short-Term Pavement Markings used on the Project will be rated according to the American Traffic Safety Services Association’s (ATSSA) *Quality Standards for Work Zone Traffic Control Devices*. The definition of “acceptable,” “marginal,” and “unacceptable” and the evaluation guidelines shall be as defined in ATSSA’s *Quality Standards for Work Zone Traffic Control Devices*.

At the time of initial set up and major phase changes, 100 percent of each type of short-term pavement marking (painted, tape, raised marker) shall be classified as acceptable. The contractor shall certify in writing to the Engineer that all short-term pavement markings installed are classified as acceptable.

The amount of acceptable markings of each type may decrease to the limits defined in the ATSSA standards as a result of damage or deterioration during the course of work. Pavement markings evaluated as unacceptable shall be replaced within 12 hours.

Raised Pavement Markers shall be cleaned as necessary to remove dirt, mud, or other foreign material which reduces the brightness of the reflectorized sheeting.

All markings no longer required shall be removed immediately.

3. **Pay Adjustment for Short-Term Pavement Markings.** If the Project is not completed and extends into winter suspension, the Engineer will inspect the markings before suspending the Contract; and any unacceptable markings shall be repaired before the Contractor is relieved of further liability.

If the Contract must be carried through the winter due to Contractor-caused delays, markings shall be maintained throughout winter suspension by and at the Contractor’s expense.

During the maintenance period, markings which are not functioning properly shall be replaced by and at the Contractor’s expense. Failure to make these repairs will result in a reduced pay factor for the markings according to the following schedule:

% of Ineffective Striping	Pay Factor
10-20%/mile, and not more than 200 L. Ft. of markings missing in one continuous stretch	50% of Bid Price for that mile

Over 20%/mile, or more than 200 L. Ft. of markings missing in one continuous stretch

No payment for that mile

No deduction will be made for markings lost due to abrasion at approaches or due to snow removal equipment.

All markings no longer required shall be removed immediately.

4. **Acceptance of Epoxy Paint Pavement Marking.**

Upon initial inspection, as specified below, epoxy pavement marking shall demonstrate satisfactory retroreflectivity, good adhesion (resisting chipping), and proper daytime and nighttime colors.

a. **Retroreflectivity.**

(1) Acceptable Minimum Retroreflectivity Values.

MINIMUM AVERAGE RETROREFLECTIVITY VALUES FOR EPOXY PAVEMENT MARKING (mcd/m²/lux)

Period	White	Yellow
Initial*	275	180

* At least two weeks after date of marking placement.

- (2) **Retroreflectometers.** Measurements shall be taken with either a portable or mobile retroreflectometer conforming to 30-meter geometry which is defined as: the entrance angle (the angle between the illumination axis and the retroreflector axis) shall fall between 88.50 degrees and 88.76 degrees and the observation angle (the angle between the illumination axis and the observation axis) shall fall between 1.0 degrees and 1.05 degrees; and, the co-viewing angle (the complement of the entrance angle) shall fall between 2.29 degrees and 2.50 degrees. All retroreflectivity readings and data analysis will be provided by the Department at no cost to the Contractor. the Department reserves the right to:
- make daytime and/or nighttime visual inspection with or without the presence of the Contractor's representative, mainly to locate obvious or suspect areas of deficiency, and
 - determine retroreflectivity of symbols, legends and lines wider than 200 mm (8 inches) using the portable retroreflectometer only.
- (3) **Test Segments.** The following methodology will be used to evaluate retroreflectivity performance of in-service longitudinal line pavement markings:
- (a) Portable Retroreflectometer

- 1) The roadway¹ shall be divided into consecutive test segments². A test segment is defined as two miles in length. A test segment shall have one test location per line type.³
- 2) For each type of solid line, the number of readings per test location are as follows:

Roadway 0-15 miles in length: five reading per test location
Roadway >15 miles in length: three readings per test location
- 3) For solid lines, take readings 5 feet apart.
- 4) For broken lines (skip lines), test two lines per test location. Take two readings from each line. Take readings 30 inches from each end of the line.
- 5) For 10 percent of each message type, take five readings on each message line; for 10 percent of each symbol type, take five readings on each symbol.
- 6) Upon completion of the evaluation, regardless of the results, additional test segments may be ordered by the Engineer.

¹ **Roadway:** As used here, means that portion of a street or highway ordinarily used for vehicular traffic. In the event a street or highway includes two or more separate roadways, the term roadway shall refer to each roadway separately.

² **Test Segments:** Areas of a roadway chosen for measuring retroreflectivity of the line types.

³ **Line Type:** Longitudinal lines of the same color and function. For example, white and yellow edge lines are each a line type.

(b) Mobile Retroreflectometer

- 1) Calibration of the instruments shall be in accordance with the manufacturer's instructions.
- 2) Retroreflectivity shall be measured at a minimum rate of 20 percent of each test segment by line type.
- 3) Should another mobile unit be available, the maximum acceptable deviation for measurements made by the two different instruments of the same manufacturer and for the same roadway length shall be ± 10 percent.
- 4) Repeatability for the given mobile unit shall be ± 6 percent.
- 5) Upon completion of the evaluation, regardless of the results, additional test segments may be ordered by the Engineer.

(c) Miscellaneous Controls

- 1) Take measurements on a clean, dry roadway.
- 2) Collect data in direction of traffic flow.
- 3) Measurement units are: mcd/m²/lux.
- 4) Randomly select test locations within a segment unless night reviews or other knowledge supersedes a random selection process.
- 5) Measure each line type separately.
- 6) The Engineer may request additional readings or test segments.
- 7) In the event LASERLUX is not available, the Engineer may require the use of the portable retroreflectometer or establish an alternative evaluation plan.

(4) Contents of Retroreflectivity Report.

(a) The report shall consist of:

- 1) State Project number.
- 2) Trunk Highway number.
- 3) Test date.
- 4) Geographical location of the readings, including distance from the nearest permanent site identification, such as a reference point.
- 5) Identification of the pavement marking material tested: type, color, age, and transverse location on the road.
- 6) Identification of the retroreflectometer.
- 7) Remarks concerning the overall condition of the line, messages and symbols such as carryover of asphalt, snow plow damage, uneven distribution of beads, etc.
- 8) Average of the readings for each test segment with one standard deviation calculated.
- 9) Average of the readings for each message and symbol type.

b. **Correction of Defects/Penalties.**

- (1) All pavement markings not conforming to the requirements of the Contract shall be removed and replaced or otherwise repaired to the

satisfaction of the Engineer. Removal of unacceptable work shall be accomplished with suitable blasting or grinding equipment unless other means are authorized by the Engineer.

- (2) Where yield computations show a deficiency in material usage of not more than 20 percent, the Department may require satisfactory repair or may accept the work at a reduced unit price which is in direct proportion to the percent of the deficiency. Where the deficiency in material usage exceeds 20 percent, the Department may require removal and replacement to the satisfaction of the Engineer unless other means are approved by the Engineer.
- (3) If the Engineer requires removal and replacement, the contractor shall remove (by an approved process) at least 90 percent of the deficient line, with no excessive scarring of the existing pavement. The removal width shall be one inch wider all around the nominal width of the pavement marking to be removed.
- (4) Where retroreflectivity falls below the minimum acceptable levels, but not more than 20 percent, the Engineer may require satisfactory repair or may accept the work at a reduced unit price which is in direct proportion to the percent of the deficiency. Where the deficiency in retroreflectivity exceeds 20 percent (i.e. less than 220 mcd/m²/lux for white and 144 mcd/m²/lux for yellow), the Engineer may require the removal and replacement to the satisfaction of the Engineer unless other means are approved by the Engineer.
- (5) If this process has to be repeated on several projects with either the same contractor and/or manufacturer(s), the Department will take corrective action. This corrective action will be a two step process:

Step 1: Pavement marking contractor/manufacturer(s) will be considered not approved for Department projects, except to bring workmanship/product back into compliance.

Step 2: If the first step cannot be attained, pavement marking contractor/manufacturer(s) will not be allowed to participate in Department projects.

762.05 METHOD OF MEASUREMENT.

- A. **Pavement Marking-Painted Line.** This item will be measured by the Linear Foot of the various widths of painted line, complete, in place, and accepted. Only the painted portion of broken lines will be measured. Pavement Marking-Painted Messages will be measured by the square footage shown on the Plans, in place, and accepted by the Engineer.
- B. **Plastic Pavement Marking Film, Pavement Marking Sheeting, and Preformed Patterned Pavement Marking Film.** This item will be measured by the Linear Foot of the various widths of installed line, complete, in place, and accepted. Only the installed portion of broken lines will be measured. Messages will be measured by the square footage shown on the Plans, in place, and accepted by the Engineer.

C. Short-Term Pavement Markings.

1. **Short Term - ___-Inch Line (Painted, Tape, or Raised Markers).** This item will be measured by the linear foot in place. The longitudinal gaps will not be measured. If raised pavement markers are used, the length of measurement will be the length of a pavement line that would exist if paint had been installed.
2. **Short Term - ___-Inch Line, Type R.** This item will be measured by the linear foot in place.
3. **Short Term - ___-Inch Line, Type R-WR.** This item will be measured by the linear foot in place.
4. **Short Term - ___-Inch Line, Type NR.** This item will be measured by the linear foot in place.
5. **Short Term - Message, Type R.** This item will be the square footage as shown on the Plans in place.
6. **Short Term - Message, Type R-WR.** This item will be the square footage as shown on the Plans in place.
7. **Short Term - Message, Type NR.** This item will be the square footage as shown on the Plans in place.

D. Raised Pavement Markers. This item will be measured by the individual unit (Each) complete and in place.

E. Obliteration of Pavement Marking. This item will be measured by the square foot of pavement marking removed. Overlaps used when covering existing markings shall not be paid for.

F. Grooved Pavement Markings.

1. **Preformed Patterned Pavement Marking - ___ inch line (Grooved).** Preformed Patterned Pavement Marking - ___ inch line (Grooved) will be measured by the linear foot of the various widths of line installed and accepted by the Engineer.
2. **Preformed Patterned Pavement Marking - Message (Grooved).** Preformed Patterned Pavement Marking—Message (Grooved) will be measured by the square footage of pavement marking message installed and accepted by the Engineer.

G. Epoxy Paint Pavement Marking - ___ Inch Line. This item will be measured by the Linear Foot of the various widths of installed line, complete, in place, and accepted. Only marked portions of broken lines will be measured.

H. Epoxy Paint Pavement Marking - Messages. This item will be measured by the square footage shown on the Plans, in place, and accepted by the Engineer.

762.06 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
Pavement Marking Painted - ___ INCH LINE	Linear Foot
Pavement Marking Painted - Message	Square Foot
Plastic Pavement Marking Film - ___ INCH LINE	Linear Foot
Plastic Pavement Marking Film - Message	Square Foot
Preformed Patterned Pavement Marking - ___ INCH LINE	Linear Foot
Preformed Patterned Pavement Marking - Message	Square Foot
Pavement Marking Sheeting - ___ INCH LINE	Linear Foot
Pavement Marking Sheeting - Message	Square Foot
Short Term - ___-INCH LINE (Painted, Tape, or Raised Markers)	Linear Foot
Short Term - ___-INCH LINE, Type R	Linear Foot
Short Term - ___-INCH LINE, Type R-WR	Linear Foot
Short Term - ___-INCH LINE, Type NR	Linear Foot
Short Term - Message, Type R	Square Foot
Short Term - Message, Type R-WR	Linear Foot
Short Term - Message, Type NR	Square Foot
Short Term - Painted Line (Seal Jobs)	Linear Foot
Raised Pavement Markers	Each
Obliteration of Pavement Marking	Square Foot
Preformed Patterned Pvmt. Marking - ___ INCH LINE (Grooved)	Linear Foot
Preformed Patterned Pvmt. Marking - Message (Grooved)	Square Foot
Preformed Plastic - ___-INCH LINE	Linear Foot
Epoxy Paint Pavement Markings - ___ INCH LINE	Linear Foot
Epoxy Paint Pavement Marking - Message	Square Foot

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

The price bid for Type R marking film shall include the cost of installation and removal.

SECTION 764 GUARDRAIL

764.01 DESCRIPTION.

This work consists of installing, removing, and resetting guardrail and box beam median barrier.

764.02 MATERIALS.

Materials shall meet the following:

Item	Section
Concrete, Class AE	802
Reinforcing Steel	836.02 A
Cable Guardrail, Wire Rope, and Fittings	862.02

W-Beam Guardrail, Guardrail Units, and Fittings	862.03
Treated Wood Guardrail Posts	862.04
Steel Guardrail Posts	862.05
Box Beam	862.06

764.03 CONSTRUCTION REQUIREMENTS.

- A. **General.** The guardrail shall be installed to produce a smooth continuous line with uniform height.

Guardrail posts shall be installed where staked and to the depth specified. Posts shall be set plumb with the front faces uniformly aligned.

Posts may be driven using a suitable head to prevent damage to the post. Damaged posts shall be replaced at the Contractor's expense. The post being replaced shall be installed by drilling. A post cap must be used when minor vertical adjustments are made using a sledgehammer or maul.

When posts are installed in augured or dug holes, the holes shall be backfilled with approved material and the surplus excavated material disposed of at locations acceptable to the Engineer. The backfill shall be placed and compacted in 8-inch layers, using a mechanical tamper with an appropriate sized tamping head without displacing the post alignment.

Drilling post holes in pavement shall be done without damage to the surrounding pavement. The proposed drilling method and equipment shall be approved by the Engineer before work is begun. Backfill shall be as described above except that the final 8 inches of backfill shall be bituminous material approved by the Engineer.

Underground utilities or structures shall not be damaged when installing posts or anchor units. Any damage to utilities or structures shall be repaired at the Contractor's expense according to Section 105.03.

Concrete pedestals shall be cast in place.

No burning or welding will be permitted in the field or after the material has been galvanized. Only drilling will be allowed on the work site.

Galvanized surface that has been damaged in transporting, handling, or erecting shall be repaired at the Contractor's expense. The damaged area shall be thoroughly cleaned by wire brushing and painted with two coats of matching zinc-rich paint.

All bolts and nuts, except adjustment bolts, shall be drawn tight. Bolts shall extend at least 1/4 inch but no more than 1 inch beyond the nuts.

Guardrail materials laid out along the shoulder at the work site and not installed by the end of the work day, shall be removed according to Section 107.05 A. Post end, beam, and end terminal sections shall be erected in a continuous operation within each individual run of guardrail and each individual run shall be completed the same day. Incomplete guardrail installation shall be marked by vertical panels, drums, and reflectorized plates at a 50-foot maximum spacing.

Reflectorized plates shall be new and shall be furnished and installed as shown in the Contract.

On projects where the roadway will be open to traffic during construction, delineator drums shall be installed at 25-foot intervals adjacent to the work site at each location where existing guardrail is removed, or where no guardrail previously existed, or at guardrail extensions. The delineator drums shall remain in place until the installation of the guardrail at that location is complete and accepted by the Engineer.

Parking of equipment and vehicles, and the storage of materials, shall meet Section 107.05 A.

At bridge connections, the attachment brackets shall be fabricated so the attachment bolt holes can be field drilled to fit the in-place bridge posts and rails. All rail shall be field drilled for connection to attachment brackets and furnished with necessary shims to meet alignment requirements.

B. Cable Guardrail. Cable guardrail shall be erected to obtain a smooth continuous taut rail.

All cable slack shall be eliminated by over-tensioning the cable as much as possible and then backing off to the required tension.

The rail will have reached the required tension when the cable will deflect no more than 5 inches in a 12-1/2-foot span under a central load of:

- 200 pounds when the temperature is 100°F.
- 220 pounds when the temperature is 80°F.
- 240 pounds when the temperature is 60°F
- 260 pounds when the temperature is 40°F

The tension shall be the same in all cables and throughout the length of the rail.

Intermediate anchors shall be spaced at intervals not to exceed 1,000 feet on tangents and outside of horizontal curves. Cable shall not be installed on the inside of curves sharper than 4 degrees. On the inside of curves at 4 degrees or flatter, intermediate anchors shall be spaced at intervals shown on the Standard Drawings.

Concrete bearing blocks may be precast or cast in place. Concrete anchors shall be cast in place and the earth surrounding the anchor shall not be disturbed.

At all locations where cable is connected to a cable socket with a wedge-type connection, one wire of the wire rope shall be crimped over the base of the wedge to hold it firmly in place.

C. W-Beam Guardrail. The rail sections shall be joined so the splices are lapped to flow in the direction of the traffic nearest the guardrail. Plate ends in lap splices shall make contact throughout the entire area of the splice.

A manufacturer's representative shall be available, as needed, for the installation of the guardrail end treatments. The Contractor shall furnish three copies of the installation instructions and drawings of the guardrail end terminals to the District

Engineer. One copy is for the Project Engineer, one copy is for the District Engineer, and one copy is for the Traffic Safety Engineer. The detailed drawings shall contain all components of the end treatment assembly.

- D. **Removal of Guardrail.** The undamaged guardrail, wood and steel posts not to be reset shall be removed and stockpiled within the Right of Way at designated locations, and shall become the property of the Department. Guardrail and posts designated for salvage or reuse that are damaged by the construction operations shall be replaced at the Contractor's expense.
1. **Cable Guardrail.** The salvage cable shall be in rolls for ease of handling.
 2. **W-Beam Guardrail.** Rail removed for reset shall be in lengths not to exceed 50 feet. Rail removed and not to be reset, shall be disassembled at each joint or splice.
 3. **Box Beam Guardrail.** Rail removed for reset shall be in lengths not to exceed 36 feet. Rail removed and not to be reset, shall be disassembled at each joint or splice.
 4. **End Treatment and Transition.** The rail and end treatment not to be reset shall be disassembled at each joint or splice. The concrete anchors for the end posts shall be removed and disposed of by the Contractor outside the Right of Way.
 5. **Miscellaneous Hardware.** All miscellaneous hardware from the removed guardrail shall be placed in containers at the stockpile site.
 6. **Anchors.** If the Engineer determines that the concrete end anchors and anchor rods do not interfere with other construction, they may be cut off one foot below ground level and the surface restored to match the surrounding area. When concrete anchors are removed, the holes shall be backfilled with approved material in 8-inch layers. Each layer shall be thoroughly tamped using a mechanical tamper. The removed concrete will be disposed of outside the Right of Way by the Contractor.
 7. **Disposal of Unsalvageable Materials.** All concrete posts, damaged wood or steel posts, damaged rail and hardware shall be disposed of by the Contractor outside the Right of Way.
- E. **Reset Cable Guardrail.** The Contractor shall modify the existing guardrail as shown on the Plans and Standard Drawings.

When the Plans call for resetting of 4-cable guardrail, the Contractor shall furnish and install new posts, hook bolt assemblies, turn buckle tie rods, bearing blocks, concrete anchors, and splicing materials as required for the new installation.

On wedge-type connections, one wire of the wire rope shall be crimped over the base of the wedge to hold it firmly in place.

The backfill shall be thoroughly tamped using a mechanical tamper.

- F. **Reset W-Beam Guardrail.** Guardrail used for Reset W-Beam Guardrail and the material for replacement of bent or damaged sections shall be obtained from salvage.

The connector used for attachment to the retrofit bridge rail shall be furnished and installed as shown in the Contract.

- G. **Reset Box Beam Guardrail.** Material for Reset Box Beam Guardrail and for replacement of bent or damaged sections shall be obtained from salvage unless otherwise directed.
- H. **Completion Requirements.** On projects where existing guardrail is to be removed or removed and replaced or reinstalled, and the roadway will be open to traffic during construction, the guardrail installation at each site shall be completed within ten working days from the day all other controlling items of work are sufficiently complete to allow guardrail installation to commence. A guardrail installation is defined as each individual run of guardrail (i.e., a typical bridge would have four guardrail installations). Controlling items of work for a guardrail installation include, but are not limited to: structure, structure end block, barrier, paving, guardrail and grading work (all within each individual run of guardrail).

Prior to any guardrail removal, a written construction schedule for work at the guardrail-installation area shall be developed by the Contractor and Subcontractors (if any), and reviewed by the Engineer. At a minimum, the schedule of work will include a sequence of controlling items and the timing of each. If the Contractor removes guardrail prior to the work plan being reviewed by the Engineer, the Engineer may apply the disincentives listed below. Work shall not cease at any individual guardrail installation for more than four working days, between controlling items of work. Additionally, the Contractor shall give each controlling item of work the constant attention necessary to facilitate continuous progress, at each guardrail installation.

If the Contractor fails to complete the required work, at fixed objects, within the time allowed, the Contractor shall provide the "Short-Term End Treatment for Bridges" shown in the Standard Drawings. The type of treatment shall be at the option of the Contractor. The cost of furnishing and installing the Short-Term End Treatment for Bridges shall be included in the price bid for guardrail installation. If the Contractor chooses to place the guardrail end treatment, the material used for this installation shall not be reused in the final guardrail installation. The Short-Term End Treatment shall remain the property of the Contractor.

Prior to removing the existing guardrail at steep-slope or culvert-extension sites, the Contractor shall essentially complete all work except guardrail installation, if any.

If the Contractor fails to comply with all requirements of Section 764.03 H, the Department reserves the right to:

1. Suspend progressive estimate payments.
2. Apply a contract price reduction of \$300 per day, if the deficiency is not remedied within 24 hours of notification to correct such item.
3. Have the Short-Term End Treatment installed by other forces, with the costs deducted from monies due or that become due the Contractor. Materials from this installation shall become the Prime Contractor's property, upon removal, and shall not be used for the permanent installation.

4. Invoke any other disincentive allowed by the Contract.

- I. **Attenuating Crash Cushions:** The attenuating crash cushion shall be installed in the locations shown on the Plans. The attenuating crash cushion shall consist of energy-absorbing material surrounded by a framework of steel, panels, and a nose cover fabricated from plastic or other material with a yellow color. Also concrete slab and anchorage units. The unit shall be able to withstand the environment extremes in the state of North Dakota and operate as specified in this environment.

The units shall have been crash tested in accordance with NCHRP Report 350, Test Level 2 or 3, and approved by the FHWA in writing. The FHWA approval letter shall be provided to the Construction Office with the attenuating crash cushion shop drawings.

The nominal width of the system shall be as shown on the Plans. The unit shall be installed in accordance with the manufacturer's recommendation. A Class AAE-3 concrete slab shall be constructed for each unit as recommended by the manufacturer. All anchorage requirements for the unit to concrete slab shall be installed in accordance with the manufacturer's recommendations. Transition panels shall be installed from the unit to the barrier end or transition as shown on the Plans. Within 50 days of contract execution by the Department, the Contractor shall furnish to the Engineer, for review, eight sets of shop drawings for crash-attenuating cushion, in accordance with Section 105.08. The shop drawings shall include manufacturer's specifications, erection instructions, maintenance instructions, and the FHWA approval letter.

764.04 METHOD OF MEASUREMENT.

- A. **Guardrail.** Guardrail will be measured by the linear foot of guardrail complete, in place, and accepted by the Engineer. The cost of furnishing and installing all posts, anchors, end treatments, bridge connections, and other items necessary to complete the guardrail installation shall be included in the payment for guardrail. Costs of drilling, backfilling, and bituminous material will not be paid separately, but shall be included in the price bid for "Guardrail."

Reflectorized plates will not be measured but shall be included in the bid items for installing or resetting guardrail.

- B. **Remove Guardrail and Posts.** Removing, salvaging, and stockpiling guardrail materials will be measured by the Linear Foot.
- C. **Reset Guardrail.** Measurement will be by the Linear Foot of reset guardrail complete and accepted by the Engineer.

Cost of furnishing and installing the W-Beam Terminal Connector shall be measured and paid for by the Linear Foot of Reset W-Beam Guardrail.

- D. **Median Barrier.** Measurement will be by the Linear Foot of median barrier complete and accepted by the Engineer.
- E. **End Treatment and Transition.** Measurement will be by the individual item (each).

- F. **Vertical Panels.** Measurement will be by each vertical panel complete and in place.
- G. **W-Beam Guardrail End Terminal.** W-Beam Guardrail End Terminals will be measured by the unit for each unit installed and accepted by the Engineer.
- H. **Attenuating Crash Cushion.** Measurement will be by the number of complete units installed and accepted by the Engineer.

764.05 BASIS OF PAYMENT.

Payment will be made at the Contract Unit Price for the following:

Pay Item	Pay Unit
_____ Guardrail	Linear Foot
Remove _____ Guardrail and Posts	Linear Foot
Reset _____ Guardrail	Linear Foot
Median Barrier	Linear Foot
Box Beam End Treatment	Each
_____ End Treatment and Transition	Each
Reset _____ End Treatment and Transition	Each
Vertical Panels	Each
W-Beam Guardrail End Terminal	Each
Attenuating Crash Cushion	Each

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

SECTION 766 MAILBOX ASSEMBLIES

766.01 DESCRIPTION.

This work consists of removing existing mailbox assemblies, furnishing and installing new support systems at locations shown on the Plans, and transferring and fastening the existing or new boxes to the new support systems.

766.02 MATERIALS.

Mailbox support systems and hardware shall be as shown on the Plans. Other support systems meeting the dimensions, metal thickness, strength, and galvanizing requirements are acceptable if they have been crash tested and approved by FHWA.

766.03 CONSTRUCTION REQUIREMENTS.

The mailbox owner will be required to furnish a postal service approved mailbox, either new or existing, for installation on the new support system. Maintenance of the new support and mailbox will be the responsibility of the Owner.

If construction activities require the removal of the existing support system but delay the installation of the permanent system, the Contractor shall temporarily reinstall the existing system, or furnish and install a temporary system at a location approved by the Engineer.

When construction has progressed sufficiently to allow permanent installation, the Contractor shall install the mailbox assemblies and mailboxes at specified locations and according to details shown on the Plans.

766.04 METHOD OF MEASUREMENT.

Permanent mailbox assemblies will be measured by each Unit complete and in place. The types of assemblies (“single,” “double,” and “multiple”) will be shown on the Plans but will not be measured separately. All types will be grouped together under the Pay Item.

766.05 BASIS OF PAYMENT.

Pay Item	Pay Unit
Mailbox (All Types)	Each

This payment will be full compensation for all labor, equipment, and materials necessary to complete the work.

SECTION 800
MATERIALS

**SECTION 801
GENERAL STATEMENT**

801.01 ACCEPTANCE OF MATERIAL

801.02 SPECIFICATION OR SPECIAL PROVISION REQUIREMENTS

**SECTION 802
PORTLAND CEMENT CONCRETE**

802.01 DESCRIPTION

- A. General
- B. Classification
 - 1. Classes
 - 2. Air-Entrainment Designation
 - 3. Coarse Aggregate Designation
- C. Composition of Concrete
 - 1. General
 - 2. Cement Content
 - 3. Water Content and Consistency
 - 4. Aggregate Content
 - 5. Admixtures
 - 6. Fly Ash
- D. Air-Entrained Concrete
 - 1. Air Content
 - 2. Method of Entraining Air
- E. High-Early-Strength Concrete
 - 1. Methods
 - 2. Conditions for Use
- F. Tests on Concrete
 - 1. General
 - 2. Slump
 - 3. Air Content
 - 4. Weight per Cubic Foot
 - 5. Tests for Uniformity
 - 6. Strength Tests

802.02 MATERIALS

802.03 EQUIPMENT

802.04 CONSTRUCTION REQUIREMENTS

- A. Handling and Storing Materials
 - 1. Handling and Storing Cement or Fly Ash
 - 2. Handling and Storing Aggregates
- B. Batching of Concrete Materials
 - 1. Batching by Weight
 - a. General
 - b. Batching Cement
 - c. Batching Fly Ash
 - d. Batching Aggregate
 - e. Batching Water
 - 2. Batching by Volume
- C. Measuring and Dispensing Admixtures

- D. Mixing and Transporting Concrete
 - 1. General
 - 2. Mixing in Stationary Mixers
 - 3. Truck-Mixed Concrete

**SECTION 804
CEMENT AND LIME**

- 804.01 CEMENT
- 804.02 LIME

**SECTION 806
GROUTS AND MORTAR**

- 806.01 RAPID-HARDENING CEMENTITIOUS MATERIALS
- 806.02 EPOXY RESIN ADHESIVES

**SECTION 808
CONCRETE ADMIXTURES**

- 808.01 AIR-ENTRAINING ADMIXTURES
- 808.02 CHEMICAL ADMIXTURES

**SECTION 810
CONCRETE CURING MATERIALS**

- 810.01 CURING MATERIALS
 - A. Burlap Cloth from Jute or Kenaf
 - B. Liquid-Membrane-Forming Compounds, White Pigmented, Type 2
 - C. Liquid-Membrane-Forming Compounds, White Pigmented, Type 2, Class B
 - D. Geotextile Fabric

**SECTION 812
WATER**

- 812.01 WATER

**SECTION 816
AGGREGATES**

- 816.01 FINE AGGREGATE FOR CONCRETE
 - A. General
 - 1. Gradation

- 2. Test Methods and Requirements
- 816.02 COARSE AGGREGATE FOR CONCRETE
 - A. General
 - 1. Gradation
 - 2. Test Methods and Requirements
- 816.03 AGGREGATES FOR SURFACING, BASE, ASPHALT MIXES, BLOTTER, AND SEAL COATS
 - A. General
 - B. Specific Requirements
 - C. Sampling and Testing

**SECTION 817
SALVAGED BASE COURSE**

- 817.01 GENERAL REQUIREMENTS
- 817.02 MATERIALS
 - A. General
 - B. Contractor Supplied Salvaged Material
 - C. Processed Virgin Aggregate for Blend
 - D. Processed Virgin Aggregate In Lieu of Salvaged Base
 - E. Use of Removed Materials
 - F. Bituminous Combined Material
 - G. Concrete Combined Material

**SECTION 818
BITUMINOUS MATERIALS**

- 818.01 GENERAL REQUIREMENTS
- 818.02 SPECIFIC REQUIREMENTS
 - A. Asphalt Cement
 - B. Rapid-Curing Cutback Asphalt
 - 1. Manufacture
 - 2. Properties
 - C. Medium-Curing Cutback Asphalt
 - D. Cationic Emulsified Asphalt
 - E. Anionic Emulsified Asphalt
 - F. Recycling Agent
 - G. Slow-Curing Cutback Asphalt

**SECTION 820
FLY ASH**

- 820.01 GENERAL

**SECTION 822
PENETRATING WATER REPELLENT**

- 822.01 GENERAL

- 822.02 TESTING
 - A. Absorption
 - B. Chloride Ion Penetration

**SECTION 824
DAMPPROOFING AND WATERPROOFING**

- 824.01 PRIMER
- 824.02 ASPHALT FOR DAMPPROOFING AND WATERPROOFING
- 824.03 WOVEN COTTON FABRIC

**SECTION 826
JOINT MATERIALS**

- 826.01 GENERAL
- 826.02 MATERIALS
 - A. Hot Applied Joint Sealant
 - 1. Type 1
 - 2. Type 2
 - 3. Type 3
 - 4. Type 4
 - B. Cold Applied Joint Sealant
 - 1. Type 5
 - C. Preformed Expansion Joint Fillers for Structural Construction
 - D. Preformed Expansion Joint Filler for Concrete (Bituminous Type)
 - E. Rubber Gaskets
 - F. Flexible Gaskets
 - G. Preformed Elastomeric Compression Joint Seal for Concrete

**SECTION 830
PIPE**

- 830.01 CONCRETE PIPE
 - A. Concrete Sewer, Storm Drain, and Culvert Pipe
 - B. Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
 - C. Precast Reinforced Concrete Manhole Sections
 - D. Fasteners and Tie Bolts
- 830.02 METAL PIPE
 - A. Ductile Iron Sewer Pipe
 - B. Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts, Storm Drains, and Underdrains
 - C. Corrugated Aluminum Alloy Culverts and Underdrains
 - D. Smooth Wall Steel Pipe Culvert
 - E. Structural Plate for Pipe, Pipe Arches, and Arches
 - F. Aluminum Alloy Structural Plate for Pipe, Pipe Arches and Arches
 - G. Polymer-Coated Corrugated Steel Pipe
- 830.03 PLASTIC PIPE

- A. Plastic Pipe for Non-Pressure Drainage of Sewage and Surface Water (outside buildings)
- B. Plastic Pipe for Water Distribution Lines (outside buildings)
- C. Plastic Drain, Waste and Vent (DWV) Pipe and Fittings
- D. Plastic Hot and Cold Water Distribution Systems (inside buildings)
- E. Plastic Gas Pipe, Tubing, and Fittings
- F. Corrugated Polyethylene Culverts

**SECTION 834
STRUCTURAL STEEL AND RELATED MATERIALS**

834.01 STRUCTURAL STEEL

- A. Structural Carbon Steel
- B. High Strength, Low Alloy Steel
- C. High Strength, Low Alloy Structural Steel
- D. High Strength Steel Plate
- E. Structural Steel for Pins and Rollers

834.02 MISCELLANEOUS METAL

- A. Steel Forgings
- B. Steel Castings
 - 1. Carbon Steel Castings
 - 2. Chromium Alloy Steel Castings
- C. Gray Iron Castings
- D. Malleable Castings
- E. Ductile Iron Castings
- F. Bronze Bearing and Expansion Plates
- G. Rolled Copper Alloy Bearings and Expansion Plates
- H. Cast Aluminum
- I. Lead Sheets and Plates
- J. Brass Sheets
- K. Copper Sheets

834.03 BOLTS, NUTS, AND WASHERS

- A. Unfinished Regular Bolts and Nuts
- B. High Tensile Strength Bolts, Nuts, and Washers
 - 1. Manufacturing
 - 2. Testing
 - 3. Documentation
 - 4. Shipping
- C. Direct Tension Indicators

834.04 PERMANENT METAL CONCRETE FORMS

**SECTION 836
REINFORCING STEEL**

836.01 HEAT NUMBER

836.02 BARS

- A. Deformed and Plain Billet Bars for Concrete Reinforcement
- B. Epoxy Coated Reinforcing Bars

C. Fabricated Steel Bar or Rod Mats for Concrete Reinforcement

836.03 WIRES

- A. Welded Deformed Steel Wire Fabric
- B. Deformed Steel Wire for Concrete Reinforcement
- C. Welded Steel Wire Fabric
- D. Cold Drawn Steel Wire for Concrete Reinforcement
- E. High Tensile Wire Strand and Bars
 - 1. Post-Tensioning Steel
 - 2. Pre-Tensioning Steel

836.04 DOWEL BARS AND TIE BARS FOR PAVEMENT JOINTS

**SECTION 840
PILING**

840.01 STEEL PILING

- A. Steel H-Piling and Special Sections
- B. Shells for Steel Encased Concrete Piling

840.02 TIMBER PILING

- A. Requirements
- B. Dimensions
- C. Treatment

840.03 SHEET PILING FOR PERMANENT INSTALLATION

- A. Steel Sheet Piling
- B. Corrugated Steel Sheet Piles

**SECTION 844
STRUCTURAL TIMBER, LUMBER AND HARDWARE**

844.01 STRUCTURAL TIMBER AND LUMBER

844.02 HARDWARE

- A. Timber Connectors
- B. Hardware

**SECTION 846
PRESERVATIVES AND PRESSURE TREATMENT
PROCESSES FOR TIMBER**

846.01 TIMBER PRESERVATIVES

**SECTION 848
MASONRY UNITS AND BRICK**

848.01 MATERIALS

- A. Concrete Masonry Units for Construction of Catch Basins and Manholes
- B. Building Brick (made from Clay or Shale)

**SECTION 852
PAINTS, OILS, AND THINNERS**

- 852.01 MATERIALS
 - A. Aluminum Paint
 - B. Lamp Black
 - C. Chrome Yellow and Chrome Orange
 - D. Enamels

**SECTION 854
GALVANIZING**

- 854.01 GALVANIZING
- 854.02 DAMAGED GALVANIZED COATINGS

**SECTION 856
EROSION CONTROL BLANKET AND
TURF REINFORCEMENT MAT**

- 856.01 EROSION CONTROL BLANKET
- 856.02 TURF REINFORCEMENT MAT
- 856.03 STAPLES
- 856.04 FABRIC FORMED SLOPE PROTECTION

**SECTION 858
GEOTEXTILE FABRICS**

- 858.01 GENERAL
 - A. Geotextile Fabrics
 - B. Concrete Curing Fabric

**SECTION 860
FENCE**

- 860.01 CHAIN LINK FENCE
- 860.02 BARBED WIRE, WOVEN WIRE, AND STAPLES
 - A. Barbed Wire
 - B. Woven Wire
 - C. Staples
- 860.03 STEEL POSTS

- A. Line Posts
 - B. Angle-Type End, Corner and Pull Posts
- 860.04 WOOD POSTS

**SECTION 862
GUARDRAIL AND POSTS**

- 862.01 GENERAL
- 862.02 WIRE ROPE AND FITTINGS FOR CABLE GUARDRAIL
- A. Socket Baskets and Wedges
 - B. Threading
 - C. Bolts, Nuts, and Washers
 - D. Washer Plates
 - E. Substitutes
- 862.03 GUARDRAIL UNITS AND FITTINGS FOR W-BEAM GUARDRAIL
- A. Button Headed Bolts and Hex Bolts
 - B. Plates
 - C. Washers
 - D. Break-Away Cable Terminal Assembly
 - E. W-Beam Guardrail End Treatments
- 862.04 TREATED WOOD GUARDRAIL POSTS
- A. Quality
 - B. Peeling and Trimming
 - C. Preservative Treatment
- 862.05 STEEL GUARDRAIL POST
- 862.06 BOX BEAM
- A. Rail Tests
 - B. Splice Plates and Expansion Plates
 - C. Bolts, Nuts, and Washers
 - D. Certification
 - E. Galvanizing

**SECTION 868
INSULATION BOARD (POLYSTYRENE)**

- 868.01 REQUIREMENTS

**SECTION 880
PAVEMENT MARKINGS**

- 880.01 PAVEMENT MARKING PAINT
- A. General
 - 1. Quality
 - 2. Manufacturing and Packaging of Preapproved Paint
 - 3. Package Stability of Preapproved Paint

- B. Specific Requirements for Solvent-Based Traffic Marking Paint
 - C. Specific Requirements for Water-Based Traffic Marking Paint
 - D. Sampling, Testing, and Accepting
 - 1. Quantitative Requirements for Paint
 - a. Pigment (Solvent Based and Water-Based Paints)
 - b. Viscosity (Solvent Based and Water-Based Paints)
 - c. Total Solids (Vehicle Solids for Solvent-Based and Acrylic Emulsion Vehicle Solids for Water-Based Paints)
 - d. Drying Time Requirements
 - 2. Quantitative Requirements for Pigment
 - a. White Traffic Paint - Titanium Dioxide (Solvent-Based and Water-Based Paint)
 - b. Yellow Traffic Paint - Lead Chromate (Solvent Based Paint)
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**SECTION 894
HIGHWAY SIGNS AND POSTS**

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 - 1. Welding Steel
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SECTION 801 GENERAL STATEMENT

801.01 ACCEPTANCE OF MATERIAL.

Acceptance of all material shall be as specified in Section 106.

801.02 SPECIFICATION OR SPECIAL PROVISION REQUIREMENTS.

Where the Department's Specifications or Special Provisions require that materials meet AASHTO, ASTM, AWPA or other Specification, the latest Specifications together with all interim Specifications which have been printed and distributed before the date of the invitation for bids shall apply.

SECTION 802 PORTLAND CEMENT CONCRETE

802.01 DESCRIPTION.

- A. **General.** Portland Cement Concrete shall be composed of Portland Cement, aggregates, water, and any required or permitted admixtures or fly ash proportioned and mixed according to these Specifications.
- B. **Classification.**
1. **Classes.** These Specifications divide concrete into three general classes by cement (including fly ash when allowed) and water content as follows:

CEMENT CONTENT*		
CLASS OF CONCRETE	Sacks (94 lb.) per Cu. Yd.	MAXIMUM WATER CONTENT Gals. per Sack of Cement*
AA or AAE	6.5	5.00
A or AE	6.0	5.35
Y or YE	5.5	5.75

*Cement content includes fly ash when allowed.

The class of concrete to be used for any item of work shall be as designated in the Contract.

2. **Air-Entrainment Designation.** The letter “E” following the alphabetical designation indicates air-entrained concrete.
3. **Coarse Aggregate Designation.** Section 816.02 A divides coarse aggregate into three size numbers based on gradation. The size of coarse aggregate to be used in the mix is designated by the numeral following the alphabetical designation for the class of concrete.

If the coarse aggregate size is not designated in the Contract, Size No. 3, 4, or 5 coarse aggregate may be used, subject to satisfactory results.

C. Composition of Concrete.

1. **General.** The concrete mix will be designed by the Engineer according to the requirements for cement, water, aggregate, and for air content. Adjustments to the aggregate and water content may be made to produce a mix with the required composition, workability, and consistency. No adjustments in compensation will be made because of any increase or decrease in costs which may result from adjustments in aggregate proportions or water content.
2. **Cement Content.** The mix proportions will be adjusted as necessary to maintain the required cement content within a tolerance of ± 2 percent by weight. The cement content for the class of concrete being mixed shall be as shown in Section 802.01 B.1 except as follows:
 - a. If the concrete produced in the field does not meet the desired design strength, the cement content shall be increased until the strength requirements are met.
 - b. The Contractor will be reimbursed for additional cement required for the Department’s benefit according to Section 602.05 C.
3. **Water Content and Consistency.** The water content of the mixed concrete includes the quantity of mixing water measured into the batch plus any free water on the surface of the aggregates, but does not include water absorbed by the aggregates. The water content shall be the minimum required to produce a workable, plastic mix having a consistency which permits a satisfactory rate of discharge, proper placement, and consolidation of the concrete. For vibrated placing, the slump of the concrete should not exceed 3 inches before addition of admixtures. Where concrete is pumped from the mixer or truck, the slump shall be adjusted at the mixer to give the proper consistency at the point of deposit in the forms.

The maximum water content per sack of cement shall not exceed the quantity shown in Section 802.01 B.1 for the class of concrete being mixed.

4. **Aggregate Content.** The aggregate content of the concrete mix will be based on a saturated surface-dry condition of the aggregates. The Engineer will determine the relative proportions of fine and coarse aggregates and adjust the batch quantity of each aggregate as necessary to compensate for any free water on the surface of the aggregate or for any water that will be absorbed by the aggregate.

5. **Admixtures.** Substances other than cement, water, aggregates, and air-entraining agents shall not be used in the concrete except when a water reducing and retarding admixture is required by the Contract or approved by the Engineer. No reduction will be made in the specified cement content of the concrete mixture when admixtures are used. Admixtures containing calcium chloride and admixtures which interfere with proper control of the entrained air content of concrete shall not be used. Permission to use any admixtures may be withdrawn if the properties of the admixture are not uniform or if satisfactory results are not being obtained.

Should the Contractor request and obtain permission to use admixtures, no additional compensation will be allowed for the cost of furnishing and incorporating the admixture into the concrete mixture.

Specified admixtures will not be paid for directly but shall be included in the cost of the concrete.

A retarding admixture shall be required in Class AAE-3 concrete for bridge decks whenever the temperature of the concrete or the ambient air temperature at the time of placement exceeds 75°F. The proposed admixture shall be submitted for approval before use.

6. **Fly Ash.**

Fly ash replacement of cement is allowed on a 1:1 ratio, up to a maximum of 29 percent by weight. Fly ash shall meet the requirements of Section 820.

Fly ash will not be allowed as a cement substitute when high-early-strength concrete is used.

D. **Air-Entrained Concrete.**

1. **Air Content.** The air content for air-entrained concrete shall not be less than 5 percent nor more than 8 percent of the volume of the freshly-mixed concrete.
2. **Method of Entraining Air.** Air may be entrained in the concrete by use of air-entraining cement, by an approved admixture, or by a combination of air-entraining cement and an approved admixture. The method used shall be at the option of the Contractor.

When air-entrained cement is used, an approved air-entraining admixture in the quantity required to maintain the air content within specified limits shall be furnished at the Contractor's expense.

Air-entraining admixtures shall be dispensed into the batch according to the requirements of Section 802.04 C.

E. **High-Early-Strength Concrete.**

1. **Methods.** High-early-strength concrete may be obtained by either of the following methods:

- a. When Type I, IA, or II cement is used, the cement content shall be increased to 7.2 sacks of cement per cubic yard. The maximum water content shall be the same as the water content shown in Table 802.01 B.1. for the class of concrete specified.
 - b. When high-early-strength cement Type III or IIIA is used, the cement content shall be as shown in Table 802.01 B.1 for the class of concrete being mixed.
2. **Conditions for Use.** High-early-strength concrete shall be used when specified in the Contract.

If not specified, but requested by the Engineer, and high-early-strength concrete is ordered; the Contractor will be reimbursed for the extra cost of the high-early-strength cement (Type III or III A) or of the additional cement (Type I, IA, or II) used. Reimbursement will be according to Section 602.05.

When the Contractor requests and obtains permission to use high-early-strength concrete, no additional payment will be made for any extra costs incurred in producing and placing the high-early-strength concrete. High-early-strength concrete shall not be used on bridge decks.

F. Tests on Concrete.

1. **General.** Any concrete tests which are necessary to ensure proper control of the mix and compliance with the Specifications will be made according to the Department's *Field Sampling and Testing Manual*. The Contractor shall furnish the concrete necessary for these tests and provide suitable facilities for curing and storing test specimens.

Concrete will be sampled for testing when the concrete is discharged at the site of placement.

- 2. **Slump.** Consistency will be measured by slump tests according to AASHTO T 119.
- 3. **Air Content.** The air content of air-entrained concrete will be measured according to AASHTO T 152.
- 4. **Weight Per Cubic Foot.** The weight per cubic foot of concrete, batch volume, and cement content will be determined according to AASHTO T 121.
- 5. **Tests for Uniformity.** Uniformity will be tested by comparing the slump, air content, and coarse aggregate content of 2 individual samples taken from approximately the 1/6 and 5/6 points of the batch as discharged at the site of placement. The uniformity will be considered satisfactory if the results of the two samples do not differ by more than the following:
 - a. Slump 3/4 inch or 25 percent of the average of the two samples, whichever is greater
 - b. Air Content 1 percent by volume of concrete; and

- c. Coarse Aggregate Content . . . 6 percent by weight of the respective (portion of each sample retained when washed through a No. 4 sieve) samples

If the test results are not within the ranges specified above, the mixing time, batch size, or equipment methods used to proportion, mix, and transport the concrete shall be changed to produce concrete meeting all specified requirements.

6. **Strength Tests.** Concrete test specimens for compression and flexural strength tests will be made and cured according to AASHTO T 23. Concrete cylinders will be tested for compressive strength according to AASHTO T 22. Concrete beams will be tested for flexural strength according to AASHTO T 97.

802.02 MATERIALS.

- A. **General.** Unless otherwise specified, Type I, IA, or II cement shall be used.
- B. Materials shall meet the following:

Item	Section
Cement	804.01
Air-Entraining Admixture	808.01
Chemical Admixtures	808.02
Curing Materials	810.01
Water	812.01
Fine Aggregate	816.01
Coarse Aggregate	816.02
Fly Ash	820.01

802.03 EQUIPMENT.

Equipment shall meet the following:

Item	Section
General	151.01
Batching and Weighing Equipment	153.01
Mixer	153.02
Concrete-Transporting Equipment	153.03

802.04 CONSTRUCTION REQUIREMENTS.

A. Handling and Storing Materials.

1. **Handling and Storing Cement or Fly Ash.** Cement or fly ash of different types, brands, or sources shall be handled and stored separately. Cement or fly ash shall not be inter-mixed during use or used alternately in any one unit. Storage that protects the cement or fly ash against dampness shall be provided. Cement which contains caked lumps or is salvaged from spillage shall not be used.

2. **Handling and Storing Aggregates.** Each separate aggregate component of different source or grading shall be handled and stockpiled separately. Adequate equipment and material shall be provided to assure a continuous batching operation. Changes in the source of aggregates during the progress of the work shall not be made unless authorized.

Aggregate hauling units shall not be operated on the stockpile. The provisions of Section 106.06 shall govern in constructing and handling of stockpiled material.

Aggregates which become intermixed with aggregates of different source or grading, or become contaminated by foreign materials shall be rejected and removed from the work site.

Aggregate will be rejected if segregation is found in any component unless the aggregate is uniformly remixed to meet the specified gradation.

Each stockpile site shall be cleared of vegetation and extraneous matter; and the ground shall be smooth, firm, and well drained. The bottom one foot of any stockpile shall not be used.

Washed aggregates shall be drained for at least eight hours before use to ensure a stable and uniform moisture content. The moisture content shall not be considered stable if there is evidence of gravity drainage in the weigh hoppers or truck boxes. The moisture content shall not be considered uniform if the variations in moisture content of any aggregate component causes fluctuations in the consistency of successive batches of the mixed concrete. Freshly washed aggregates shall be stored separately from the drained aggregates in use.

B. Batching of Concrete Materials.

1. Batching by Weight.

- a. **General.** When directed by the Engineer, the Contractor shall test the batching operation accuracy. The batched ingredient shall be weighed on a platform scale certified by the Department of Weights and Measures (North Dakota Public Service Commission) or a certified scale service. The Contractor shall bear all expenses and fees incurred in the accuracy tests.
- b. **Batching Cement.** Bulk cement shall be measured by weight with equipment meeting Section 153.01. The bulk cement batch weight shall not vary from the designated weight by more than ± 1 percent. Sacked cement furnished shall be considered to weigh 94 pounds per sack. Fractional sacks of cement shall not be used unless weighed.
- c. **Batching Fly Ash.** Bulk fly ash shall be measured by weight with equipment meeting Section 153.01. The bulk fly ash batch weight shall not vary from the designated weight by more than ± 1 percent.
- d. **Batching Aggregate.** Each separate aggregate component shall be measured by weight with equipment meeting Section 153.01. The ag-

gregate batch weight of each aggregate component shall not vary from the designated weight by more than ± 2 percent.

- e. **Batching Water.** The mixing water for each batch may be measured by volume or by weight with equipment meeting Section 153.01 A. The designated quantity of mixing water shall be added to each batch, within a tolerance of ± 1 percent.

- 2. **Batching by Volume.** If a mobile mixer is used, it shall meet Section 153.02 C.

- C. **Measuring and Dispensing Admixtures.** Any admixtures used in the concrete shall be accurately measured and dispensed using the manufacturer's recommendations to give a uniform distribution. Equipment and methods for measuring admixtures, the quantity of admixture used, and the time the admixture and water are placed in the batch shall be approved by the Engineer. The dispensing device shall repetitively control the batching of the admixture within an accuracy of ± 5 percent of the required volume of material or ± 1 fluid ounce, whichever is greater. Dispensing equipment shall be arranged to permit convenient, visual observation of the volume of admixture dispensed or the admixture may be dispensed by other approved mechanical or manual methods. Dispensing equipment shall be periodically checked and cleaned.

Where more than one admixture is used in the same batch, the admixtures shall be added separately to prevent contact in their concentrated form.

The Contractor may be required to produce trial batches of the concrete mix with the admixture before use to determine if the water reduction, set retardation, air content, and strength of the concrete mixture meets requirements. The same equipment, batch size, materials, etc., proposed for the work shall be used in preparation of these trial batches. If all test requirements are met, the trial batches may be incorporated into the work.

D. **Mixing and Transporting Concrete.**

- 1. **General.** The concrete may be mixed at the site of placement or by approved ready-mix methods. All concrete shall be mixed in approved, mechanically operated mixers meeting Section 153.02.

The concrete shall be mixed in the quantity required to provide continuous placement and finishing operations. Addition of water to retemper concrete is not permitted.

The mixer shall be operated so successive batches of concrete do not become merged or intermixed during the mixing cycle.

All concrete shall be mixed until the cement, water, aggregates, and admixtures are uniformly distributed. The concrete shall meet all requirements for slump, air content, and uniformity at the point of placement.

- 2. **Mixing in Stationary Mixers.** Stationary mixed concrete is concrete mixed completely in a central mixing plant.

The batch volume may exceed the rated capacity of the mixer by 10 percent, provided that concrete test data for strength and uniformity are satisfactory and the batch can be mixed without spillage.

The mixing time shall be measured from the time all solid materials are in the drum until discharge of that batch begins. The drum shall be charged so a portion of the mixing water enters in advance of the aggregates and cement. All remaining water shall be added after charging the aggregate and cement and before 1/4 of the mixing time has elapsed. Transfer time in multiple-compartment mixers shall be included in mixing time. The mixing time per batch shall be a minimum of 60 seconds, except that: (1) when the concrete is used in pavement, the Engineer may give written permission to reduce the mixing time to a minimum of 50 seconds if concrete test data for strength and uniformity meet Specifications; and (2) if the mixer is temporarily operated under manual timing control or has a rated capacity of less than 10 cubic feet, the concrete shall be mixed for a minimum of 90 seconds.

Concrete shall be delivered to the site of placement in an agitating truck, in a truck mixer operated at agitating speed, or in approved non-agitating equipment. The interval of time between introducing the cement to the mixture and the time the concrete has been completely discharged, shall not exceed 30 minutes in non-agitating equipment and 60 minutes in agitating equipment. These time limits shall be reduced if weather conditions affect the concrete adversely.

3. **Truck-Mixed Concrete.** Truck-mixed concrete is concrete proportioned at a central plant and mixed and delivered to the site of placement in a truck-mixer (known as ready-mixed concrete).

Truck-mixed concrete shall not be produced until all equipment, facilities, and methods for handling and storing materials and for proportioning, mixing, and transporting the concrete have been approved. If the concrete is not delivered to the site of placement at the times and rates necessary for continuous placement and finishing; or if the consistency, air content, or other properties of the concrete do not conform to specified requirements the use of truck mixed concrete shall be discontinued.

Equipment for transporting concrete shall meet Section 153.02 B. The volume of concrete placed in the truck-mixer shall not exceed the maximum capacity shown on the manufacturer's rating plate. The truck-mixer shall be cleaned at periodic intervals to prevent accumulation of hardened concrete, and shall be emptied of all free water before receiving any batch ingredients. The interval between the time cement has been placed in contact with the aggregates or the water and the time the concrete has been completely discharged shall not exceed 60 minutes. The maximum discharge time limit may be reduced if weather conditions affect the concrete adversely during the specified time interval.

Mixing shall not be less than 70 revolutions nor more than 100 revolutions after all ingredients are charged in the truck-mixer. If the batch volume is 90 percent or less than the rated mixing capacity, mixing may be reduced to a minimum of 50 revolutions. After mixing is completed, additional revolutions shall be at agitating speed. If water is added, the mixing drum shall be run an additional 30 revolutions at mixing speed after mixing has begun or been completed. Mixing and agitating speeds used shall follow the manufacturer's recommendations within the limits specified in Section 153.02 B.

Transit-mixed concrete shall be completely discharged at the site of placement within 60 minutes after the cement has been placed in contact with either the aggregate or the water. The 60-minute time limit may be extended by the Engineer to a maximum of 90 minutes if the ambient air and the concrete mix temperature at the time of mixing is less than 80°F., and if the mixed concrete meets the specified requirements for maximum water content and air content when discharged at the site of the work. The mix must be completely discharged within the 90 minutes. Addition of water to concrete will not be permitted after the 60-minute time limit.

SECTION 804 CEMENT AND LIME

804.01 CEMENT.

Portland cement shall conform to AASHTO M 85 for the type specified except as herein modified:

Allow the addition of 5.0 percent limestone by mass (weight) in the cement. Only interground limestone that is naturally occurring, consisting of at least 70 percent by mass of one or more of the mineral forms of calcium carbonate will be allowed.

Fineness shall be measured by the air permeability test (all cement types except Type III):

Fineness, Specific Surface Air Permeability Test

Air Permeability Test	Square Meter per Kilogram
Average value, min	360.0
Minimum value, any one sample	340.0
Average value, max	420.0
Maximum value, any one sample	440.0

When Specifications require that low alkali cements be used the total alkalis in the Portland cement ($\text{Na}_2\text{O} + 0.658 \text{K}_2\text{O}$) shall not exceed 0.60 percent. The total alkalis in the cementitious material shall not exceed 5.0 pounds per cubic yard.

Blended Hydraulic cement shall conform to AASHTO M 240.

804.02 LIME.

Hydrated lime shall meet AASHTO M 216.

SECTION 806 GROUTS AND MORTAR

806.01 RAPID-HARDENING CEMENTITIOUS MATERIALS.

This material shall meet ASTM C 928. If no type is specified, the material shall meet Type R1.

806.02 EPOXY RESIN ADHESIVES.

This material shall meet AASHTO M 235 Type IV Grade III.

**SECTION 808
CONCRETE ADMIXTURES**

808.01 AIR-ENTRAINING ADMIXTURES.

Air-entraining admixtures shall meet AASHTO M 154.

808.02 CHEMICAL ADMIXTURES.

Chemical Admixtures shall meet AASHTO M 194.

**SECTION 810
CONCRETE CURING MATERIALS**

810.01 CURING MATERIALS.

A. Burlap Cloth made from Jute or Kenaf.

Curing materials shall meet the following:

Burlap Cloth made from Jute or Kenaf AASHTO M 182

B. Liquid-Membrane-Forming Compounds, White Pigmented, Type 2

Curing materials shall meet the following:

Liquid-Membrane-Forming Compounds,
White Pigmented, Type 2 AASHTO M 148

C. Liquid-Membrane-Forming Compounds, White Pigmented, Type 2, Class B

The resin used in the curing compound shall be 100 percent poly-
alphanethylstyrene and conform to all requirements in the following:

Properties	Minimum	Maximum
Total Solids, % by weight of compound	42	
% Reflectance in 72 hours (ASTM E 1347)	65	
Loss of Water, kg/m ² in 24 hours (ASTM C 156)		0.15
Loss of Water, kg/m ² in 72 hours (ASTM C 156)		0.40
Setting Test, mL/100 mL in 72 hours		2
V.O.C. Content, g/L		350
Infrared Spectrum Vehicle	100% alpha-methylstyrene	

The Settling Test procedure is available at the Department's Materials and Research Division.

The shelf life of the product shall be six months from the date of manufacture.

Curing materials shall meet the following:

Liquid-Membrane-Forming Compounds,
White Pigmented, Type 2, Class B AASHTO M 148

- D. Geotextile Fabric.** The Geotextile fabric shall be a highly absorbent fabric made from a light colored, nonwoven material that weighs a minimum of 8 ounces per square yard.

SECTION 812 WATER

812.01 WATER.

Water used in mixing or curing concrete, cement-treated bases, lime-treated bases, and fly ash treated bases shall be clean and free of oil, acid, alkali, organic matter, and other substances damaging to the finished product. Water will be tested according to AASHTO T 26. Water known to be of potable quality may be used without testing. Where the source of water is relatively shallow, the intake shall be enclosed to exclude silt, mud, grass, or other foreign materials.

When water used for mixing with Portland Cement has a pH value less than 4.5 or more than 8.5, the water shall be tested by casting and testing mortar cubes according to AASHTO T 106. The seven-day compressive strengths shall equal at least 90 percent of the companion test specimens made using distilled water.

The water must also meet the autoclave expansion and time of setting tests criteria given in AASHTO T 26.

SECTION 816 AGGREGATES

816.01 FINE AGGREGATE FOR CONCRETE.

- A. **General.** Fine aggregate for concrete shall meet AASHTO M 6 with the following changes:

1. **Gradation.** Fine aggregate shall meet the following:

Sieve Size	Percent Passing
3/8 Inch	100
No. 4	95-100
No. 16	45-80
No. 50	10-30
No. 100	0-10
No. 200	0-3

2. **Test Methods and Requirements.** Only the following tests from AASHTO M 6 will be used:

Test	Method	Requirements
Sampling	AASHTO T 2	
Reducing Sample to Test Size	AASHTO T 248	
Lightweight pieces in Aggregate	AASHTO T 113*	2% max.
Organic impurities	AASHTO T 21	Not darker than the reference std. color
Mortar-making properties	AASHTO T 71	
Sieve analysis	AASHTO T 27	
Soundness (sodium sulfate)	AASHTO T 104	10% max.
Material Passing No. 200 Sieve	AASHTO T 11	

*Oven-dry weights will be substituted for saturated surface-dry weights. The percentage of lightweight pieces will be based on the total sample submitted for testing. Lightweight pieces will be those with a specific gravity less than 1.95. The No. 30 sieve will be substituted for the No. 50 sieve. Agitate the sample by stirring for a period of 15 seconds. Allow the sample to settle for 30 seconds and decant. Perform this procedure until the specimen is free of floating pieces or a maximum of three times.

816.02 COARSE AGGREGATE FOR CONCRETE.

- A. **General.** Coarse Aggregate shall consist of gravel, crushed gravel, crushed stone, or other approved inert materials of similar characteristics, or a combination thereof, meeting the following:

1. **Gradation.** The gradation shall meet the following:

Size No. and Percent Passing by Weight

Sieve Size	3	4	5
1-1/2 inch	100		
1 inch	95-100	100	
3/4 inch		90-100	100
1/2 inch	25-65		90-100
3/8 inch	15-55	20-55	40-70
No. 4	0-10	0-10	0-15
No. 8	0-5	0-5	0-5
No. 200 (Max)	1.0	1.0	1.0

2. Test Methods and Requirements.

Test	Method	Requirements Max. Percent by Weight of the Plus No. 4 Fraction
a. Shale	NDDOT Method**	0.7
b. Iron Oxide Particles	NDDOT Method**	4.0*
c. Lignite and Other Coal	NDDOT Method**	0.5
d. Soft Particles Exclusive of a, b, c (Includes clay, and other friable material)	NDDOT Method**	2.5
e. Thin or Elongated Pieces (maximum thickness less than 1/4 the maximum width, or maximum length more than three times the maximum width)	NDDOT Method**	15.0
f. Material Passing No. 200 Sieve	AASHTO T 11	
g. L.A. Abrasion	AASHTO T 96	40.0
h. Soundness (Sodium Sulfate)	AASHTO T 104	12
i. Sampling	AASHTO T 2	
j. Reducing Sample to Test Size	AASHTO T 248	
k. Sieve Analysis	AASHTO T 27	

*NOTE: For spall repairs for concrete pavements and for bridge deck overlays, the maximum iron oxide particles shall be 2.0 percent.

**Field Sampling and Testing Manual

Coarse aggregate for use in concrete that is subjected to moisture, extended exposure to humid atmosphere, or contact with moist ground shall not contain any materials that are deleteriously reactive with the alkalis in the cement in a quantity sufficient to cause excessive expansion of mortar or

concrete. If such materials are present in injurious quantities, the coarse aggregate may be used with a cement containing less than 0.6 percent alkalis calculated as sodium oxide or with the addition of a material that has been shown to prevent harmful expansion due to the alkali-aggregate reaction. The reactivity shall be determined according to the test methods specified in AASHTO M 80.

816.03 AGGREGATES FOR SURFACING, BASE, ASPHALT MIXES, BLOTTER, AND SEAL COATS.

- A. **General.** The material shall consist of sound, durable particles of gravel or sand which may include limited quantities of fine soil particles as binding material. It shall be free of sod, roots, and other organic matter. The physical characteristics and quality of the materials shall be approved by the Engineer.

CLASS OF AGGREGATE AND SPECIFICATION LIMITS

B. Specific Requirements.

Table I: Aggregates for Subgrade Repair, Trench Backfill, Bases, and Surfacing

Sieve Size Percent Passing	2	3	Aggr. for Subgrade Repair ³	3M	4	5	7	8	13
3"		100							
1-1/2"								100	
1-1/4"									
1"			100			100	100		100
3/4"	100	80-100	80-100		100	90-100	95-100		70-100
5/8"									
1/2"									
3/8"	50-95						85-100		
No. 4		35-85	35-85		35-85	35-70	15-25	35-80	38-75
No. 8							2-10		22-62
No. 10	0-15								
No. 16									
No. 30	0-4	20-50	20-50		10-50	16-40			12-45
No. 50									
No. 100									
No. 200		0-15	4-10		7-17	4-10	0-3		7-15
Shale ¹		12%	12%		15%	12%	8%	20%	12%
L. A. Abrasion ¹					50%	50%	40%		50%
Plasticity Index ²									
Fractured Faces ³					10%	10%	85%		10%

Footnotes for Tables I and II:

¹ Maximum Allowable Percentages.

² Maximum allowable unless ranges shown. N.P. = Non Plastic as per AASHTO T-90. Use material passing the No. 40 sieve (standard method). For Class 5 aggregate the maximum allowable Plasticity Index shall be determined from the following formula: Max. allowable PI for Class 5 = 10 - (% Passing No. 40 Sieve / 10)

³ Minimum weight percentage allowable for the portion of the aggregate retained on a No. 4 sieve having at least 1 fractured face for Classes 4, 5, 13, 27, 29, 31, and 33, and at least 2 fractured faces for Class 7.

⁴ Minimum percentage of material passing a No. 4 sieve that is composed of fractured material produced by a crushing process. The Contractor shall demonstrate that the crushing operation produces this result.

⁵ Salvaged Base meeting the requirements of Section 302 and 817 may be substituted for Cl. 3 or Cl. 5 virgin aggregate, unless otherwise specified on the Plans.

Table II: Aggregates for Asphalt Mixes, Blotter, and Seal Coats

Sieve Size Percent Passing	Asphalt Hot Mix Low to High Quality					Chip Seal 41	Chip Seal 42	Chip Seal 43	Blotter Sand 44	Sand Seal 45
	27	29	31	33	33					
3"										
1-1/2"										
1-1/4"										
1"										
3/4"										
5/8"	100	100	100	100	100				100	
1/2"	70-100	70-100	70-100	70-100	70-100					100
3/8"						100	100	100		100
No. 4	40-70	40-70	40-70	40-70	40-70	20-70	20-70	20-70	90-100	85-100
No. 8						0-17	2-20	0-17		45-80
No. 16										
No. 30	15-35	15-35	15-35	15-35	15-35					
No. 50										10-30
No. 200	2.0-7.0	2.0-7.0	2.0-7.0	2.0-7.0	2.0-7.0	0-1.5	0-5	0-2	0-20	0-3
Shale ¹	5.0%	5.0%	5.0%	5.0%	5.0%	8.0%	8.0%	8.0%		3.0%
L. A. Abrasion ¹	40%	40%	40%	40%	40%	40%	40%	40%		40%
Plasticity Index ²	3	3	N.P.	N.P.	N.P.					
Fractured Faces ³	55%	65%	75%	95%	95%					
Crushed Fines ⁴	10%	40%	60%	80%	80%					

Footnotes for Tables I and II:

¹ Maximum Allowable Percentages.² Maximum allowable unless range shown. N.P. = Non Plastic as per AASHTO T-90. Use material passing the No. 40 sieve (standard method). For Class 5 aggregate the maximum allowable Plasticity Index shall be determined from the following formula: Max. allowable PI for Class 5 = 10 - (% Passing No. 40 Sieve / 10)³ Minimum weight percentage allowable for the portion of the aggregate retained on a No. 4 sieve having at least 1 fractured face for Classes 4, 5, 13, 27, 29, 31, and 33, and at least 2 fractured faces for Class 7.⁴ Minimum percentage of material passing a No. 4 sieve that is composed of fractured material produced by a crushing process. The Contractor shall demonstrate that the crushing operation produces this result.⁵ Salvaged Base meeting the requirements of Section 302 and 817 may be substituted for Cl. 3 or Cl. 5 virgin aggregate, unless otherwise specified on the Plans.

C. Sampling and Testing.

Sampling	AASHTO T 2
Reducing Sample to Test Size	AASHTO T 248
Liquid Limit	AASHTO T 89
Plastic Limit and Plasticity Index	AASHTO T 90
Los Angeles Abrasion	AASHTO T 96
Lightweight Pieces of Aggregate	AASHTO T 113*
Sieve Analysis	AASHTO T 27
Amount of Material Finer than No. 200 Sieve in Aggregate	AASHTO T 11**
Fractured Faces	Department Method

*Oven-dry weights will be substituted for saturated surface-dry weights. The No. 30 sieve will be substituted for the No. 50 sieve. The percentage of lightweight pieces will be based on the total sample retained on the No. 30 sieve. Lightweight pieces will be those with a specific gravity less than 1.95. Agitate the sample by stirring for a period of 15 seconds. Allow the sample to settle for 30 seconds and decant. Perform this procedure until the specimen is free of floating pieces or a maximum of three times.

**AASHTO T 11 is to be used in conjunction with AASHTO T 27 for all aggregate tests.

SECTION 817 SALVAGED BASE COURSE

817.01 GENERAL REQUIREMENTS.

Salvaged Base may be composed of the following materials: processed virgin aggregate, existing aggregate base, existing bituminous material, stockpiled bituminous material, existing concrete material, and/or stockpiled concrete material. All removal material shall be incorporated into the Salvaged Base as detailed in the plans unless otherwise approved in accordance with section 817.02 E. One-hundred percent processed virgin aggregate as specified in section 817.02 D may be supplied to make-up any difference between the Salvaged Base quantity producible from the removal quantities and the required Salvaged Base quantity. Additionally, any removal quantities in excess of that required for Salvaged Base production shall become the Contractor's property.

The "Basis of Estimate" contained in the Plans indicates the approximate removal quantities, the quantity of aggregate necessary to supplement the salvaged material, and the approximate blend percentages to be used to produce the Salvaged Base Course. Depending on the Contractor's operations, the Salvaged material quantities shown in the Basis of Estimate may or may not be available when the Contractor needs to incorporate them back into the project as Salvaged Base. The Contractor is responsible for supplying the material required to make up any Salvaged Base short fall caused by project phasing. Any make up material supplied by the Contractor shall meet the requirements of Section 817.02 A. All costs for supplying this make-up material shall

be paid for as “Salvage Base.” Any material not available due to project phasing shall ultimately be incorporated into the Salvaged Base unless otherwise approved in accordance with section 817.02 E.

Materials composing the final combined Salvaged Base shall be combined with a conveyor, pugmill, bins or other mechanical device. Combining/blending on the roadway shall not be permitted.

The Contractor may elect to mine the existing pavement in place prior to removal from the roadway. If this method is used, the Contractor shall take measurements to ensure the proper depth is being mined. During the mining operation, the Contractor shall physically dig down, approximately every 500 feet (each pass), to measure the existing pavement and base depth. The results of the measurements shall be made available to the Engineer daily.

The Salvaged Base shall be free of reinforcing steel, soil, scoria, and other foreign materials.

817.02 MATERIALS.

- A. **General.** All final combined materials (i.e. Salvaged Base) shall meet the following requirements:

Sieve Size	Percent Passing	
	General	Salvaged Base under Permeable Base
1-1/2 in.	100	100
1 in.	90 - 100	90 - 100
No. 4	35 - 85	N/A
No. 30	16 - 50	N/A
No. 200	0.0 - 12.0	N/A

The continuous-reinforced concrete pavement (CRCP), jointed concrete pavement (doweled or non-doweled), median paving, sidewalks, curb and gutter, driveways, parking lots, ditch liners, existing aggregate base and bituminous pavement shown in the plans for removal shall be incorporated into the salvaged base material. In addition to the aforementioned items, any other removed concrete or bituminous materials may (at the Contractor’s option) be incorporated into the salvaged base.

The gradation “Salvaged Base under Permeable Base” will only be allowed for PCC salvaged material. The salvaged material must be verified as PCC recycle and free of deleterious materials to the satisfaction of the Engineer prior to use on the project.

- B. **Contractor Supplied Salvaged Material.** The Contractor may substitute contractor-supplied salvaged material (i.e. stockpiled material) for the removed material, as long as the removed material is not wasted and the use of the substitute material is acceptable and approved by the Engineer.
- C. **Processed Virgin Aggregate for Blend.** Virgin aggregate used for blending with the salvage material shall be; composed of non-organic granular material, have a maximum shale content of 12 percent, and have a plasticity index of 0 - 6.

- D. Processed Virgin Aggregate In Lieu of Salvaged Base.** Any virgin aggregate used in lieu of Salvaged Base shall meet the requirements for Class 5 Aggregate Base as detailed in Section 816.
- E. Use of Removed Materials.** The Contractor may request not to incorporate removed material into the Salvaged Base if it is determined that such incorporation is impractical and not in the public's best interest. The request shall be in writing, include a detailed justification as to why the use of the removed material is impractical, and is subject to the approval of the Engineer. Removal items not incorporated into the project shall become the property of the Contractor and disposed of in accordance with Section 107.10.
- F. Bituminous Combined Material.**
1. If the Contractor intends to use a stockpile containing bituminous material as the final combined Salvaged Base, he shall, under supervision of the Engineer, supply the Engineer with three (3) random samples, prior to placing any of the material on the project. These samples shall be taken in accordance with AASHTO T 2 and be at the Contractor's expense. At the Owner's expense, the samples will be tested, by extraction (AASHTO T 164), for bitumen content and the results averaged. Stockpiled material with an initial average extraction of greater than 3.5 percent will not be allowed as the final Salvaged Base. Additionally, if any one sample has an extraction of greater than 4.0 percent, the material shall not be allowed for use as the final Salvaged Base. However, the Contractor may elect to blend the material with other materials to meet the requirements of Section 817. Additionally, as specified in Section 302.02 B, routine extraction testing will be performed, when stockpiled material is supplied. In all cases, the final combined Salvaged Base shall meet all other requirements of Section 817.
 2. The Contractor may, at his option, combine stockpiled material containing bitumen with aggregate or salvaged concrete at a rate not to exceed 50 percent stockpile with 50 percent (or more) aggregate or salvaged concrete by weight, without the required extraction sampling and testing (either initial or routine as specified in Section 302.02 B). The combining of this material shall be done off of the road using mechanical equipment, as required above. The combined material shall not be stockpiled at the original stockpile site prior to delivery to the project (stockpiling in the project staging area will be allowed, as long as the staging area is not at the original stockpile site). Additionally, the final combined Salvaged Base shall meet all other requirements of Section 817.
 3. If existing bituminous material from the project is incorporated into the Salvaged Base, the bituminous material shall be incorporated at a rate less than or equal to 50 percent bituminous to 50 percent (or more) aggregate or recycled concrete, by weight. No extraction testing will be required for this material.
- G. Concrete Combined Material.**
1. Salvaged concrete (either stockpiled or existing material) may constitute any portion, up to and including 100 percent, of the final combined material. However, the final combined Salvaged Base shall meet all other requirements of Section 817.

2. Salvaged concrete shall be free of reinforcing steel, bitumen, soil and other foreign materials. If bitumen is present in the salvaged material, the material shall become subject to the requirements of Section 817.02 B, above. If steel is present in material to be used as Salvaged Base, the Contractor may use any method acceptable to the Engineer to remove the steel, which will become the property of the Contractor. If the Contractor chooses to waste the steel, it shall be disposed of according to Section 107.10.

SECTION 818 BITUMINOUS MATERIALS

818.01 GENERAL REQUIREMENTS.

The original certificate of compliance covering material shipped in each car or tank truck shall be furnished at the time of shipment. The certificate shall be furnished to the applicable Department's district office and shall contain the following information:

1. Project Number.
2. Destination.
3. Quantity Contained in Car or Tank Truck.
4. Gross, Tare, and Net Weights if Shipped by Truck.
5. Car Initials and Number or Tank Truck Number.
6. Type and Grade of Bitumen.
7. Date of Shipment.
8. Specific Gravity.
9. Statement that the material meets all of the Specifications.

818.02 SPECIFIC REQUIREMENTS.

A. Asphalt Cement

1. Penetration Graded Asphalt Cement AASHTO M 20
2. Viscosity Graded Asphalt Cement AASHTO M 226 Table 2
3. Performance Graded (PG) Asphalt Cement AASHTO M 320*

*Testing Tolerances will be allowed according to Table 1 of the Department's *Procedure for Acceptance of Performance Graded Bituminous Material*. Acceptance of PG asphalt shall be according to the Combined State Binder Test Group procedures.

B. Rapid-Curing Cutback Asphalt AASHTO M 81

C. Medium-Curing Cutback Asphalt AASHTO M 82

MC3000P shall meet the following requirements:

	AASHTO	MC3000P
Kinnematic Viscosity @ 140°F.	T 201	3000-7000
Flash Point, F (TOC)	T 79	150 min.
Water, %	T 55	0.2 max.
Distillation Test: Distillate % Volume		
to 437°F.		-
to 500°F.		0-15%
to 600°F.		15-75%
% Residue to 680°F.	T 78	80 min.
Tests on Residue from Distillation		
Penetration @ 77°F.	T 49*	250 max.
Ductility @ 77°F.	T 51	100 min.
Absolute Vix @ 140°F	T 202*	300-1200
Tests on Polymerized Base Asphalt		
Ductility @ 77°F.	T 51	100 min.
Ductility @ 39°F. (5 cm/min, cm)	T 51	50 min.
Toughness, inch-pounds	ASTM D 5801	75 min.
Tenacity, inch-pounds	ASTM D 5801	50 min.
% Polymer		2% solids min.

* Penetration or Viscosity is specified but in no case will both be required.

D. Cationic Emulsified Asphalt.

1. **Cationic Emulsified Asphalt** shall meet the requirements of AASHTO M 208 with the following exceptions:
 - a. Grade CMS-2 shall have 5 percent to 15 percent oil distillate by volume of emulsion.
 - b. Grade CMS-2h and CSS-1h, the maximum penetration permitted at 77°F. (25°C) 100 gm, 5 sec., in the "Test on Residue from Distillation Test," shall be raised to 120.
 - c. Footnote "b" of AASHTO M 208 will not apply to either the storage stability or the sieve test requirements.
2. **Modified Cationic Emulsified Asphalt.** Emulsified asphalt grades shall meet the requirements of AASHTO M 316.

E. Anionic Emulsified Asphalt AASHTO M 140

When using SS-1h, the maximum penetration permitted at 77°F (25 °C) 100 gm, 5 sec, in the "Test on Residue from Distillation", shall be raised to 120.

HFRS 2P emulsified asphalt shall be an emulsified blend of polymerized asphalt, water, and emulsifiers. The asphalt cement shall be polymerized prior to emulsification and shall contain a minimum of 3 percent polymer by weight of asphalt cement. The emulsion shall be pumpable and suitable for application through a distributor.

Tests on Emulsions	Min	Max
Viscosity, Saybolt Furol @ 122°F.	50	400
Storage Stability*		Passes
Cure Test**		Passes
Sieve (%)		0.1
Demulsibility 50ml 0.10 N CaCl ₂ , %***	40	
Oil Distillate by Volume of Emulsion, %****		3.0
Residue by Distillation, %	65	

Tests on Residue from Distillation Tests

Penetration @ 77°F. (25°C.)	100	200
Ductility @ 39°F. (4°C.) 5 cm/min. cm	30	
Softening Point (R & B) Degrees F	100	
Elastic Recovery @ 50°F. (10°C.)	55	
Float Test @ 140°F. (60°C.) sec	1200	

*Storage Stability: In addition to requirement of AASHTO T 59, on examination of the test cylinder after the emulsion has been standing undisturbed for 24 hours, the surface shall show no white, milky covered substance but shall be a homogenous brown color throughout.

**The cure test is performed as follows: Pour approximately 1 gram of (HFMS-2P or HFRS-2P) emulsion onto a metal surface (lid of a 3 oz. Ointment tin). Allow the test sample to cure at temperatures of at least 80°F under a heat light for four hours. The outdoor sunlight may be used as a testing site. After the four-hour curing period, the (HFMS-2P or HFRS-2P) emulsion shall show no tackiness or tendency to stick to the fingers when pressed.

***This test not a requirement on representative samples is waived if successful application of the material has been achieved in the field.

****The distillation test for CRS-2P emulsion shall be in accordance with AASHTO T 59, 8-12 except that the distillation temperature shall be what the emulsion manufacturer recommends.

Property	ASTM Test	HFMS-2	HFRS 2P	HFRS-2
Viscosity, Sabolt Furol @ 122°F. (50°C)	Note #1	35-150	50-200	50-200
Sieve Test, Retained on #20, max. %	Note #1	0.1	0.1	0.1
Storage Stability, 24 hour, max. %	Note #1	1.0	1.0	1.0
Asphalt Residue by Distillation, min. %	Note #2	62	65	63
Oil Portion of Distillate by volume, max. %	D 244	3.0	3.0	3.0
Float Test @ 140°F., Seconds, min.	Note #3	1200	1200	1200
Solubility in Trichlorethylene, min. %	D 4	97.5	97.5	97.5
Penetration, 77°F., 100 gm, 5 sec.	D 5	140-225	140-225	140-225
Apparent Viscosity @ 140°F.	D 4957	Note #4		Note #4

Demulsibility, 0.02 N CaCl ₂ , min. %	D 244	40	40
Demulsibility, 0.1 N CaCl ₂ , min. %		30	
Ductility, 77°F., 5 cm/min., cm, min.	AASHTO T 51	40	40
Elastic Recovery, 77°F., min. %	Note #5	58	

Note #1. ASTM Method D 244 shall be used for the Storage Stability, Sieve Test, and the Saybolt Furol Viscosity Test. The test results shall be reported, but the requirements may be waived if successful application of the material has been achieved in the field.

Note #2. AASHTO T 59 will be used except when testing the HFRS 2P the test shall be modified to include a 400 + 10°F. maximum temperature to be held for 15 minutes.

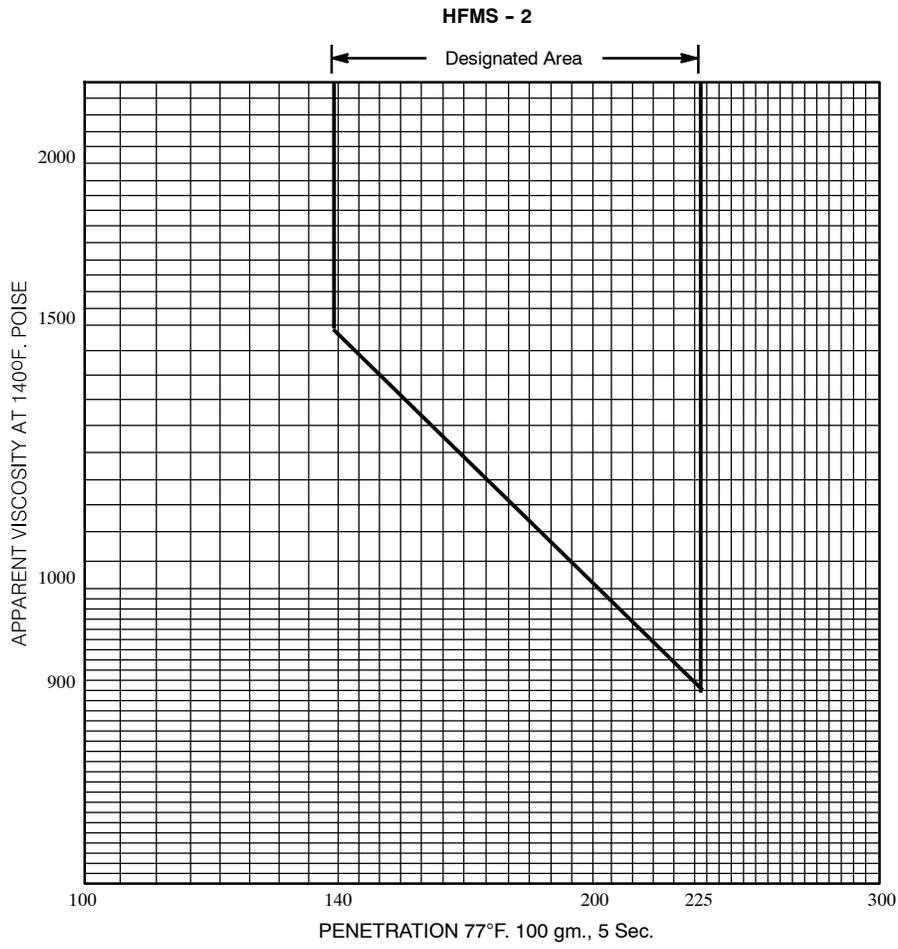
Note #3. ASTM Method D 139 shall be used to test the float. When testing HFMS-2, the residue from distillation shall be poured immediately into the float collar at 500°F. When testing HFRS-2P, the residue from distillation shall be poured into the float collar at 400°F. If the residue has been allowed to cool, it shall be reheated and poured into the collar.

Note #4. Viscosity-Penetration results shall fall within the designated area on the following chart at a shear rate of 1.0 sec⁻¹. The viscosity will be determined using a Modified Koppers size 100 viscometer tube at 140°F. and 300 mm Hg vacuum.

Note #5. AASHTO T 51 with the following modifications:

- Prepare and test one specimen.
- After filling the mold with the hot sample, cool to room temperature for a period of 30-40 minutes, then place the base plate and filled mold in the water bath maintained at 50°F. for 85-95 minutes before trimming.
- Remove the specimen from the bath and immediately position it in the ductilometer, which has a bath temperature maintained at 50°F. Proceed to elongate the specimen at the rate of 5 cm/min.
- Elongate the specimen to 20 cm, then stop the ductilometer. Immediately cut the elongated specimen approximately in half with a scissors.
- Allow the specimen to remain in the ductilometer undisturbed for 1 hour.
- Retract the movable half of the specimen until the two broken ends touch, then observe the elongated measurements.
- Calculate: $\% \text{ Elastic Recovery} = \frac{20 - X}{20} \times 100$

X = Elongated measurement after rejoining the ends of the specimen.



F. Recycling Agent.

The recycling agent shall meet the following:

Properties	Test Method	Requirements
Viscosity, 140°F., cSt	ASTM D 445	200-800
Flash Point, °F., C.O.C.	AASHTO T 48	425, Minimum
Solubility in Trichloroethylene, min. %	ASTM D 4	99.0
Saturates, max. %		30
Thin Film Oven Test	AASHTO T 179	
Loss of Heating, %		4.0%, max.
Viscosity, 140°F., cSt		Maximum of 3 time the orig. viscosity

- G. Slow-Curing Cutback Asphalt.** Slow-curing cutback asphalt shall meet ASTM D 2026, except that the minimum Flash Point for the SC 800 will be 240°F.

SECTION 820 FLY ASH

820.01 GENERAL.

Fly ash shall meet the following for the specific type of work:

Type of Work	Specification
Portland Cement Concrete	AASHTO M 295
Lime Fly Ash Treated Subgrade	ASTM C 593
Econcrete	AASHTO M 295
Aggregate Base	ASTM C 593

Sampling and testing all fly ash shall be at the Contractor's expense, except as described below.

The chemical composition of fly ash required to meet AASHTO M 295 shall be Class F (as described in Table 1 of AASHTO M 295) with the following modifications:

- A. The total of silicone dioxide (SiO_2) plus aluminum oxide (Al_2O_3) plus iron oxide (Fe_2O_3) shall be at least 66.0 percent by dry weight of the total fly ash composition.
- B. The silicon dioxide (SiO_2) shall be at least 40.0 percent by dry weight of the total fly ash composition.

C. Loss on Ignition shall be no more than 2.0 percent maximum.

D. The optional requirements of Table 2 shall be required.

In addition to the certificate described below, the Contractor shall supply fly ash test data to the Engineer in the form of a chemical and physical analysis report, prepared by an independent lab, prior to the Department proceeding with the concrete mix design. The Department may retest project samples to verify Specification compliance. The Department will select an independent lab to perform verification testing and will be responsible for cost of the testing. When performed, the verification tests will be the basis of acceptance.

Fly ash shall be from an electrical generating plant using a single coal source. Fly ash produced at plants where the limestone injection process is used for controlling air pollutants will be considered unacceptable for use in Portland Cement Concrete. The Contractor shall provide weather-tight storage facilities for the fly ash either at the source or on the Project site.

Fly ash delivered to the Department and the Project shall be accompanied by a Certificate of Compliance based on a testing program which ensures a satisfactory and uniform product relative to these Specification requirements. The Certificate of Compliance covering material shipped in each car or tank truck shall be furnished in triplicate at the time of shipment. The original is to be furnished to the Materials and Research Engineer, Department of Transportation, 300 Airport Road, Bismarck, North Dakota 58504, with one copy going to the consignee and one copy to the Engineer.

The certificate shall contain the following information:

- A. Project number and name of Contractor.
- B. Fly ash source by name of company and location of plant.
- C. Quantity contained in tank truck or railroad car.
- D. Gross, tare, and net weight if shipped by truck.
- E. Car initials and number or tank truck number.
- F. Date of shipment.
- G. Statement that the material meets all Specification requirements.
- H. Signature of the person having legal authority to bind the supplier.

SECTION 822 PENETRATING WATER REPELLENT

822.01 GENERAL.

The penetrating water repellent treatment solution shall consist of an Organo Silicon compound dissolved in a suitable solvent carrier that, when applied, produces a hydrophobic surface covalently bonded to the concrete.

The Organo Silicon compound shall be one of the following:

ALKYL-ALKOXYSILANE
OLIGOMEROUS ALKYL-ALKOXYSILOXANE

The solvent will leave less than 1 percent residue upon evaporation.

The solution shall contain a minimum of 40 percent solids. The material shall be certified to meet or exceed the performance criteria listed below based on a single application of the solution according to the manufacturer's recommended rate of coverage.

The penetration water repellent treatment solution shall not stain, discolor, or darken concrete. Application of the solution shall not alter the surface texture or form a coating on concrete surfaces and shall be compatible with the use of special surface finish texture coatings as specified. Treated concrete shall be surface dry within 30 minutes after application.

822.02 TESTING.

The treated concrete shall meet the following requirements:

A. Absorption.

Test	Duration	Max. Absorption	Method
Water Immersion	48 hrs.	1% by weight	ASTM C 642
	50 days	2% by weight	ASTM C 642

B. Chloride Ion Penetration.

Test	Duration	Max. Absorption Cl-	Method
Salt Water Ponding*	90 days	0.75 lb. per cu. yd.	AASHTO T 259
		Depth: 1/2 inch to 1 inch	AASHTO T 260

*Based on non-abraded specimens.

C. Treatment Penetration.

Test	Minimum Depth	Method
Penetration	0.15 inch	DOT Procedure*

*Refer to the Department's *Field Sampling and Testing Manual*.

D. Vapor Permeability.

Treated concrete shall retain its moisture vapor permeability as determined by the Department's test procedure.

SECTION 824 DAMPPROOFING AND WATERPROOFING

824.01 PRIMER.

Primer for use with asphalt in dampproofing and waterproofing shall meet ASTM D 41.

824.02 ASPHALT FOR DAMPPROOFING AND WATERPROOFING.

Asphalt for dampproofing and waterproofing shall meet ASTM D 449.

824.03 WOVEN COTTON FABRIC.

Woven cotton fabric saturated with bituminous substances for use in waterproofing shall meet ASTM D 173.

824.04 BLACK POLYETHYLENE MEMBRANE.

Black Polyethylene Membrane shall be a black polyethylene sheeting 0.010 inch thick plus rubberized asphalt 0.060 inch thick for a total nominal thickness of 0.070 inch. The exposed face of the rubberized asphalt shall have a removeable covering which shall remain on the membrane until it is ready to be placed.

- A. **Primer.** The primer to be used with black polyethylene membrane shall be a type recommended by the membrane manufacturer.
- B. **Joint Sealing Mastic.** The joint sealing mastic shall be a type recommended by the membrane manufacturer.

SECTION 826 JOINT MATERIALS

826.01 GENERAL

The crack sealant compound shall be packaged in sealed containers. Each container shall be clearly marked with the name of the manufacturer, the trade name of the sealant, the type of sealant, the weight, the manufacturer's batch and lot number, the pouring temperature, and the safe heating temperature.

The Contractor shall submit a sample of the sealant to the Materials and Research Division three weeks prior to being used on the Project. The sample shall be clearly marked with the Contractor's name and the Project number. Prior approval of any specific sealant material shall be required from the Materials and Research Division before it can be used on the Project.

A copy of the manufacturer's recommendations pertaining to the heating and application of the joint sealant material shall be submitted to the Engineer before the commencement of work. These recommendations shall be adhered to and followed by the Contractor. The temperature of the sealer in the field application equipment shall not exceed the safe heating temperature recommended by the manufacturer. Any given quantity of material shall not be heated at the pouring temperature for more than six hours and shall never be reheated. Material shall not be placed if the temperature is below the manufacturer's recommended minimum application temperature.

Mixing of different manufacturer’s brands or different types of sealant shall be prohibited.

Sealant materials may be placed during a period of rising temperature after the air temperature in the shade and away from artificial heat has reached 40°F. and indications are for a continued rise in temperature. During a period of falling temperature, the placement of sealant material shall be suspended when the air temperature, in the shade and away from artificial heat, reaches 40°F. Sealants shall not be placed when the weather or roadbed conditions are unfavorable.

826.02 MATERIALS

A. Hot Applied Joint Sealant.

1. Type 1 Crumb-Rubber Joint Sealant

The joint sealant material shall be a single component, hot-poured sealant meeting the requirements of AASHTO M 324 Type I and shall have a minimum softening point of 190°F. (88°C.), as determined by ASTM D 36. The sealant shall resist softening and pickup by vehicle tires in the summer and cracking in the winter when used in this application. Plasticizers and fillers may be added as necessary to meet the requirements specified.

The sealant shall consist of a blend of asphalt cement and vulcanized granulated crumb tire rubber. The asphalt cement shall meet the requirements of AASHTO M 20 or M 226. The minimum percentage of crumb tire rubber added shall be 12 percent of the total weight of the sealant-rubber mixture.

The granulated crumb tire rubber shall be free of fabric, wire, cord, and other foreign material. Calcium carbonate may be added at a rate not to exceed 4 percent of the total weight of the crumb rubber to prevent the rubber particles from sticking together. The granulated crumb rubber shall meet the following requirements:

a. Gradation.

Sieve Size	Percent Passing
#8	100
#10	95 - 100
#30	0 - 20
#50	0 - 5

b. Specific Gravity of 1.15 ± 0.02

Acceptance. Joint Sealants that meet the quality requirements specified will be accepted at the contract unit price. Sealants that fail to meet the requirements specified but the quality deviation is not serious enough to materially affect the work quality will be paid for as follow:

Price Reduction Criteria. Reduce payment for the crumb rubber joint sealer by 20 percent if the Bond or Flow fails.

The payment for Penetration is reduced by the following schedule. Use the average of the original and check sample to determine the percentage of variation.

Variation of Penetration	Deduct Factor
0.1-5%	5%
5.1-10%	10%
10.1-15%	15%
> 15%	20%

The payment for Softening Point is reduced by the following schedule. Use the average of the original and check sample to determine the temperature variation.

Temperature Variation (Degrees C)	Deduct Factor
85-87.9	5%
80-84.9	10%
< 80	20%

2. **Type 2** AASHTO M 324 Type IV
with the following modifications:

Penetration at 77°F. 120 - 150
Bond at -20°F., 3 cycles,
200 percent extension Pass
The Sealant shall weigh not less than 9.0 nor more than 9.35 lbs./gallon.

Acceptance. Joint Sealants that meet the quality requirements specified will be accepted at the contract unit price. Sealants that fail to meet the requirements specified but the quality deviation is not serious enough to materially affect the work quality will be paid for as follow:

Price Reduction Criteria. Reduce payment for the crack sealer by 20 percent if the Bond or Flow fails.

The payment for Penetration is reduced by the following schedule. Use the average of the original and check sample to determine the percentage of variation.

Variation of Penetration	Deduct Factor
0.1-5%	5%
5.1-10%	10%
10.1-15%	15%
> 15%	20%

B. Cold Applied Joint Sealant.

1. **Type 5** Low Modulus Silicone Sealant.
The Low Modulus Silicone Sealant shall be furnished in a one-part silicone formulation. The silicone sealant material shall have a movement capability of +100 percent and -50 percent of joint width. The silicone sealant material shall be tack free prior to opening the roadway to traffic. This material shall meet the following requirements:

Test	Limit	Method
Flow	0.3 inch maximum	ASTM C 639
Extrusion Rate	75-250 grams/min.	ASTM C 603
Specific Gravity	1.010-1.515	ASTM D 792, Method A

Durometer Hardness Type A: (cured 7 days at 77°F. ± 3° and 45% to 50% R.H.)	10-25 (0°F.)	ASTM D 2240
Tensile Stress (at 150% elongation, 7-day cure at 77°F. ± 3° and 45% to 50% R.H.)	45 psi maximum	ASTM D 412 (Die C)
Elongation: (7-day cure at 77°F. ± 3° and 45% to 55% R.H.)	1,000% minimum	ASTM D 412 (Die C)
Movement capability and adhesion (7-day cure in air, 77°F. ± 3° then 7 days in water, 77°F. ± 3°)	No adhesive or cohesive failure after 10 cycles (0°F.)	ASTM C 719*
Bonded to concrete mortar concrete briquets (air cured 7 days at 77°F. ± 3°)	50 psi minimum	AASHTO T 132**

*A 1-inch by 2-inch by 3-inch concrete block shall be prepared according to ASTM C 719. A sawed face shall be used for the bond surface. Two inches of block shall be sealed leaving 1/2 inch on each end of the specimen unsealed. The depth of the sealant shall be 3/8 inch and the width 1/2 inch. The sealant shall be subject to a movement according to ASTM C 719 at the rate of 1/8 inch per hour. One cycle is defined as an extension to one inch and returning to the initial 1/2 inch width.

**Briquets, molded according to AASHTO T 132, shall be sawed in half and bonded with approximately 10 mils of sealant and tested using clips meeting AASHTO T 132. The briquets shall be dried to a constant weight in an oven at 100°C. ± 5°. They shall be tested in tension at a loading rate of .3 inch/minute.

Backer rod shall be a "Type 1" rod material intended for use with cold-applied sealants in accordance with ASTM D 5249 - 95. The width of the backer rod shall be as recommended by the manufacturer for the required saw cut width. No bond or reaction shall occur between the rod and the sealant.

- C. **Preformed Expansion Joint Fillers for Structural Construction.**
..... AASHTO M 213
- D. **Preformed Expansion Joint Filler for Concrete (Bituminous Type).**
..... AASHTO M 33
- E. **Rubber Gaskets.** AASHTO M 198
- F. **Flexible Gaskets.** AASHTO M 198
- G. **Preformed Elastomeric Compression Joint Seal for Concrete.**
..... AASHTO M 220

**SECTION 830
PIPE**

830.01 CONCRETE PIPE.

The Department will evaluate the fabricator’s concrete pipe plant according to Department procedures. The results of this evaluation will determine if the material may be accepted by “Certificate of Compliance.” The results of tests shall govern acceptance or rejection of materials tested.

- A. **Concrete Sewer, Storm Drain, and Culvert Pipe.** AASHTO M 86
- B. **Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.** This pipe shall meet AASHTO M-170, M-206, or M-207 for the specified diameters and strength class except that aggregate shall meet the requirements of Section 816.01 A.2. and 816.02 A.2.
- C. **Precast Reinforced Concrete Manhole Sections.** AASHTO M 199
- D. **Fasteners and Tie Bolts.** Tie bolts and nuts shall be of steel meeting ASTM A 307 Grade A. Washers shall be of steel meeting ASTM A 366 or ASTM A 569. Fastener castings shall be gray iron castings meeting ASTM A 48 Class 20.

830.02 METAL PIPE.

- A. **Ductile Iron Sewer Pipe.** ASTM A 746
- B. **Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts, Storm Drains, and Underdrains.** AASHTO M 36
- C. **Corrugated Aluminum Alloy Culverts and Underdrains.** AASHTO M 196
- D. **Smooth Wall Steel Pipe Culvert.** Smooth wall steel pipe culvert shall be welded steel pipe of new material, meeting ASTM Specifications A 139, Grade B with a minimum yield strength of 35,000 psi. The following minimum wall thickness shall be used:

Diameter of Pipe	Minimum Wall Thickness Through Roadway Embankment	Minimum Wall Thickness Through Railroad Embankment
24 inches	0.250 inch	0.344 inch
30 inches	0.312 inch	0.406 inch
36 inches	0.375 inch	0.469 inch

- E. **Structural Plate For Pipe, Pipe Arches, and Arches.** . . . AASHTO M 167

- F. **Aluminum Alloy Structural Plate for Pipe, Pipe Arches, and Arches.**
 AASHTO M 219
- G. **Polymer-Coated Corrugated Steel Pipe**
1. **Steel Pipe.** AASHTO M 246
 2. **Polymer-Coated Corrugated Steel Pipe.** AASHTO M 245
 All Polymer-Coated Corrugated Steel Pipe shall have helical corrugations with a continuous lock seam extending the length of each pipe.
 All pipe ends shall be re-rolled to form annular corrugations extending at least two corrugations from the pipe end to facilitate field jointing.
 3. **Coupling Bands.** AASHTO M 246
 The coupling bands shall conform with the same polymer coating grade as that used for fabrication of the polymer-coated corrugated steel pipe, and having the same metallic coating.

830.03 PLASTIC PIPE.

- A. **Plastic Pipe for Non-Pressure Drainage of Sewage and Surface Water (outside buildings).** Plastic pipe for non-pressure drainage of sewage and surface water shall meet the following:
1. **Acrylonitrile-Butadiene-Styrene (ABS).** ASTM D 2680
 2. **Acrylonitrile-Butadiene-Styrene (ABS).** ASTM D 2751
 3. **Type PSM, Polyvinyl Chloride (PVC).** ASTM D 3034
 or ASTM F 949
 4. **Perforated, Corrugated, P.E., or Plastic Pipe.** AASHTO M 252
- B. **Plastic Pipe for Water Distribution Lines (outside buildings).** Plastic pipe for water distribution lines shall meet the following:
1. **Acrylonitrile-Butadiene-Styrene (ABS).** ASTM D 1527
 Schedules 40 and 80.
 2. **Polyethylene (PE).** ASTM D 2104, Schedule 40
 3. **Polyvinyl Chloride (PVC) and Chlorinated Polyvinyl Chlorid (CPVC) Plastic Pipe (SDR-PR).** The PVC and CPVC compounds shall meet ASTM D 1784 and shall be Class 12454-B (Type 1, Grade 1).
 4. **Polybutylene (PB) Plastic Pipe (SDR-PR)** ASTM D 2662
- C. **Plastic Drain, Waste and Vent (DWV) Pipe and Fittings.** Plastic drain, waste, and vent pipe and fittings shall meet the following:

- 1. **Acrylonitrile-Butadiene-Styrene (ABS).** ASTM D 2661
- 2. **Polyvinyl Chloride (PVC).** ASTM D 2665
- 3. **Polyvinyl Chloride (PVC).** ASTM D 2949
- D. **Plastic Hot and Cold Water Distribution Systems (inside buildings).** Plastic hot and cold water distribution systems shall meet the following:
 - 1. **Polybutylene (PB).** ASTM D 3309
 - 2. **Chlorinated Polyvinyl Chloride (PVC).** ASTM D 2846
- E. **Plastic Gas Pipe, Tubing, and Fittings.** ASTM D 2513
- F. **Corrugated Polyethylene Culverts.** AASHTO M 294

**SECTION 834
STRUCTURAL STEEL AND RELATED MATERIALS**

834.01 STRUCTURAL STEEL.

- A. **Structural Carbon Steel.** AASHTO M 270, Grade 36
- B. **High Strength, Low Alloy Steel.** AASHTO M 270, Grade 50
- C. **High Strength, Low Alloy Structural Steel.** . AASHTO M 270, Grade 50W
AASHTO M 270, Grade 50W steel in unpainted application shall all be of the same type and from the same source.
- D. **High Strength Steel Plate.** AASHTO M 270, Grade 100
- E. **Structural Steel for Pins and Rollers.** Structural steel for pins and rollers 9 inches or less in diameter shall meet either AASHTO M 102, Class C, D, F, or G; or AASHTO M 169, Grades 1016 to 1030.

834.02 MISCELLANEOUS METAL.

- A. **Steel Forgings.** AASHTO M 102, Classes C, D, F, or G
- B. **Steel Castings.** This material shall meet the following requirements:
 - 1. **Carbon Steel Castings.** AASHTO M 192, Class 70
 - 2. **Chromium Alloy Steel Castings.** AASHTO M 163, Grade CA 15

- C. **Gray Iron Castings.** AASHTO M 105, Class 35 B
- D. **Malleable Castings.** ASTM A 47, Grade No. 35018
- E. **Ductile Iron Castings.** ASTM A 536, Grade 60-40-18
- F. **Bronze Bearing and Expansion Plates.** AASHTO M 107, Alloys C-91300 or C-91100
- G. **Rolled Copper Alloy Bearings and Expansion Plates.** AASHTO M 108
- H. **Cast Aluminum.** AASHTO M 193
- I. **Lead Sheets and Plates.** ASTM B 29, Common Lead
- J. **Brass Sheets.** ASTM B 36
- K. **Copper Sheets.** AASHTO M 138

834.03 BOLTS, NUTS, AND WASHERS.

- A. **Unfinished Regular Bolts and Nuts.** ASTM A 307
- B. **High Tensile Strength Bolts, Nuts, and Washers.**

All bolts shall meet AASHTO M 164 and these revisions.

All nuts shall meet AASHTO M 292 as applicable or AASHTO M 291 and these revisions.

All washers shall meet AASHTO M 293 and these revisions.

1. **Manufacturing.**

a. **Bolts.**

- (1) Hardness for bolt diameters 1/2 inch to 1 inch inclusive shall be as noted below:

Bolt Size, In.	Hardness Number			
	Brinell		Rockwell C	
	Min.	Max.	Min.	Max.
1/2 to 1 inch	248	311	24	33

b. **Nuts.**

- (1) Nuts to be galvanized (hot dip or mechanically galvanized) shall be heat treated grade 2H, DH, or DH3.
- (2) Plain (ungalvanized) nuts shall be grades 2, C, D, or C3 with a minimum Rockwell hardness of 89 HRB (or Brinell hardness 180 HB), or heat treated grades 2H, DH, or DH3.

- (3) Nuts that are to be galvanized shall be tapped oversize the minimum amount required for proper assembly. The amount of overtap in the nut shall be so the nut assembles freely on the bolt in the coated condition and shall meet the mechanical requirements of AASHTO M 291 and the rotational-capacity test herein (the overtapping requirements of AASHTO M 291, paragraph 7.4 shall be considered maximum values instead of minimum, as currently shown).
 - (4) Galvanized nuts shall be lubricated with a lubricant containing a dye of any color that contrasts with the color of the galvanizing.
- c. **Marking.** All bolts, nuts, and washers shall be marked according to the appropriate AASHTO Specifications.

2. **Testing.**

a. **Bolts.**

- (1) Proof load tests (ASTM F 606, Method 1) are required. Minimum frequency of tests shall be as specified in AASHTO M 164, paragraph 9.2.4.
- (2) Wedge tests on full size bolts (ASTM F 606 paragraph 3.5) are required. If bolts are to be galvanized, tests shall be performed after galvanizing. Minimum frequency of tests shall be as specified in AASHTO M 164, paragraph 9.2.4.
- (3) If galvanized bolts are supplied, the thickness of the zinc coating shall be measured. Measurements shall be taken on the wrench flats, or top of bolt head.

b. **Nuts.**

- (1) Proof load tests (ASTM F 606, paragraph 4.2) are required. Minimum frequency of tests shall be as specified in AASHTO M 292, paragraph 7.1.2.1. If nuts are to be galvanized, tests shall be performed after galvanizing, overtapping, and lubricating.
- (2) If galvanized nuts are supplied, the thickness of the zinc coating shall be measured. Measurements shall be taken on the wrench flats.

c. **Washers.**

- (1) If galvanized washers are supplied, hardness testing shall be performed after galvanizing. (Coating shall be removed before taking hardness measurements.)
- (2) If galvanized washers are supplied, the thickness of the zinc coating shall be measured.

d. **Assemblies.**

Rotational-capacity tests are required and shall be performed on all black or galvanized (after galvanizing) bolt, nut, and washer assemblies

by the manufacturer or distributor prior to shipping. Washers are required as part of the test even though they may not be required as part of the installation procedure.

The following shall apply:

- (1) Except as modified herein, the rotational-capacity test shall be performed according to AASHTO M 164.
- (2) Each combination of bolt production lot, nut lot, and washer lot shall be tested as an assembly. Where washers are not required by the installation procedures, they need not be included in the lot identification.
- (3) A rotational-capacity lot number shall be assigned to each combination of lots tested.
- (4) The minimum frequency of testing shall be two assemblies per rotational-capacity lot.
- (5) The bolt, nut, and washer assembly shall be assembled in a Skidmore-Wilhelm Calibrator or an acceptable equivalent device. For short bolts which are too short to be assembled in the Skidmore-Wilhelm Calibrator, see Section 834.03 B.2.d.9.
- (6) The minimum rotation, from a snug tight condition (10 percent of the specified proof load), shall be:

240 degrees (2/3 turn) for bolt lengths < 4 diameters
 360 degrees (1 turn) for bolt lengths > 4 diameters and < 8 diameters
 480 degrees (1-1/3 turn) for bolt lengths > 8 diameters

- (7) The tension reached at the above rotation shall be equal to or greater than 1.15 times the required installation tension. The installation tension and the tension for the turn seat are shown below:

Diameter (In.)	1/2	5/8	3/4	7/8	1	1-1/8	1-1/4	1-3/8	1-1/2
Req. Installation Tension (kips)	12	19	28	39	51	56	71	85	103
Turn Test Tension (kips)	12	22	32	45	59	64	82	98	118

- (8) After the required installation tension listed above has been exceeded, one reading of tension and torque shall be taken and recorded. The torque value shall meet the following:

Torque: less than or equal to 0.25 PD

Where:

Torque = measured torque (foot-pounds)
 P = measured bolt tension (pounds)
 D = bolt diameter (feet)

- (9) Bolts that are too short to test in a Skidmore-Wilhelm Calibrator may be tested in a steel joint. The tension requirement of Section 834.03 B.2.d.7 need not apply. The maximum torque requirement of Section 834.03 B.2.d.8 shall be computed using a value of P equal to the turn test tension shown in the table in Section 834.03 B.2.d.7.

e. **Reporting.**

- (1) The results of all tests (including zinc coating thickness) required herein and in the appropriate AASHTO Specifications shall be recorded on the appropriate document.
- (2) Location where tests are performed and date of tests shall be reported on the appropriate document.

f. **Witnessing.**

The tests need not be witnessed by an inspection agency; however, the manufacturer or distributor that performs the tests shall certify that the results recorded are accurate.

3. **Documentation.**

a. **Mill Test Report(s) (MTR).**

- (1) MTR shall be furnished for all mill steel used in the manufacture of bolts, nuts, or washers.
- (2) MTR shall indicate the place where the material was melted and manufactured.

b. **Manufacturer Certified Test Report(s) (MCTR).**

- (1) The manufacturer of the bolts, nuts, and washers shall furnish test reports (MCTR) for the item furnished.
- (2) Each MCTR shall show the relevant information required according to Section 834.03 B.2.e.
- (3) The manufacturer performing the rotational-capacity test shall include on the MCTR:
- (a) The lot number of each of the items tested.
 - (b) The rotational-capacity lot number as required in Section 834.03 B.2.d.3.
 - (c) The results of the tests required in Section 834.03 B.2.d.
 - (d) The pertinent information required in Section 834.03 B.2.e.2.
 - (e) A statement that MCTR for the items meet this Specification and the appropriate AASHTO Specification.

- (f) The location where the bolt assembly components were manufactured.

c. Distributor Certified Test Report(s) (DCTR).

- (1) The DCTR shall include MCTR above for the various bolt assembly components.
- (2) The rotational-capacity test may be performed by a distributor (in lieu of a manufacturer) and reported on the DCTR.
- (3) The DCTR shall show the results of the tests required in Section 834.03 B.2.d.
- (4) The DCTR shall also show the pertinent information required in Section 834.03 B.2.e.2.
- (5) The DCTR shall show the rotational-capacity lot number as required in Section 834.03 B.2.d.3.
- (6) The DCTR shall certify that the MCTR are conforming to this Specification and the appropriate AASHTO specifications.

4. Shipping.

- a. Bolts, nuts, and washers (where required) from each rotational-capacity lot shall be shipped in the same container. If there is only one production lot number for each size of nut and washer, the nuts and washers may be shipped in separate containers. Each container shall be permanently marked with the rotational-capacity lot number such that identification will be possible at any stage prior to installation.
- b. The appropriate MTR, MCTR, or DCTR shall be supplied to the Engineer for acceptance prior to installation.

C. Direct Tension Indicators. ASTM F 959

834.04 PERMANENT METAL CONCRETE FORMS.

Permanent metal forms for concrete floor slabs shall be of zinc-coated (galvanized) steel sheets meeting ASTM A 924 with coating class of G 235 according to ASTM A 635.

**SECTION 836
REINFORCING STEEL**

836.01 HEAT NUMBERS.

All reinforcement delivered to a Project shall be tagged with a metal or plastic tag showing the manufacturer’s heat number. Numbers shall be embossed, engraved, or printed in waterproof ink.

836.02 BARS.

- A. **Deformed and Plain Billet Bars for Concrete Reinforcement.**
..... AASHTO M 31, Grade 40 or 60
- B. **Epoxy Coated Reinforcing Bars.** AASHTO M 284
- C. **Fabricated Steel Bar or Rod Mats for Concrete Reinforcement.**
..... AASHTO M 54, Grade 40 or 60

836.03 WIRES.

- A. **Welded Deformed Steel Wire Fabric.** AASHTO M 221
- B. **Deformed Steel Wire for Concrete Reinforcement.** AASHTO M 225
- C. **Welded Steel Wire Fabric.** AASHTO M 55
- D. **Cold Drawn Steel Wire for Concrete Reinforcement.** ... AASHTO M 32
- E. **High Tensile Wire Strand and Bars.**

1. **Post-tensioning Steel.** For the post-tensioning method of construction, the prestressing steel shall be high-tensile wire, high-tensile wire strand or rope, or high-tensile alloy bars, uncoated and stress relieved.

High-tensile wire shall meet AASHTO M 204 and high-tensile wire strand or rope shall meet AASHTO M 203. High-tensile alloy bars shall meet AASHTO M 275.

2. **Pre-Tensioning Steel.** AASHTO M 203

836.04 DOWEL BARS AND TIE BARS FOR PAVEMENT JOINTS.

Dowel bar for transverse expansion or contraction joints in Portland Cement Concrete pavement shall be plain, round bars fabricated from steel meeting AASHTO M 31 or M 322.

Dowels shall be saw cut to the required length and cleaned to remove all cutting burrs, loose mill scale, rust, grease, and oil. The bars may be sheared providing the deformation of the bars from true round shape does not exceed 0.04 inch in diameter or thickness, and shall not extend more than 0.04 inch from the sheared end.

The free end of dowels for expansion joints shall be fitted with a metal sleeve of an approved design covering 2 inches \pm 1 inch of the dowel. The sleeve shall have a closed end and a stop to hold the closed end at least one inch from the end of the dowel bar. The sleeve shall not collapse or distort in shape in handling and placing of the dowels and concrete.

All dowels shall be Epoxy coated in accordance with AASHTO M 284. Freshly exposed steel as a result of shearing, saw-cutting, or cutting by other means during the fabrication process is acceptable on the ends of tie or dowel bars used in pavement joints.

Tie bars for the centerline joint and adjoining driving lanes in Portland Cement Concrete pavement shall be epoxy coated, meeting the requirements in 836.02 B. All other tie bars shall meet AASHTO M 31, Grade 40 deformed.

SECTION 840 PILING

840.01 STEEL PILING.

- A. **Steel H-Piling and Special Sections.** Materials for steel piling and special sections shall meet AASHTO 270 Grade 50.
- B. **Shells for Steel Encased Concrete Piling.** Shells for steel encased concrete piling may be either cylindrical pipe or tapered fluted.

Cylindrical pipe shells shall be electric welded steel pipe or seamless steel pipe and shall meet ASTM A 252, Grade 2. End closure plates shall be 3/4-inch flat steel plate welded directly to the pipe and shall not project beyond the perimeter of the pile.

840.02 TIMBER PILING.

- A. **Requirements.** All Timber Piling shall be clean-peeled and meet ASTM D 25.
- B. **Dimensions.** Piles shall have the following minimum diameters:

Length of Piles	Diameter (Inches)	
	3 Feet from Butt	At Tip
Under 40 feet	12	8
40 - 74 feet	13	7
75 - 90 feet	13	6
Over 90 feet	As shown on the Plans	

- C. **Treatment.** Where required, treatment of timber piling shall be according to Section 846 and will be accepted on certification according to Section 801.01. This certificate shall include species of timber, type of preservative, and method of treatment.

840.03 SHEET PILING FOR PERMANENT INSTALLATION.

- A. **Steel Sheet Piling.** This material shall meet AASHTO M 202.
- B. **Corrugated Steel Sheet Piles.** The steel sheet piles shall be of the continuous interlock type and of the lengths and section modulus specified. The sheeting shall be new and the base metal shall be open hearth steel.

The interlock shall be formed by bending the metal through 180 degrees or more, leaving an opening of sufficient size to allow free slippage of the adjoining sheet pile, but maintaining a reasonably snug fit.

Each sheet pile shall be true, straight, and uniform in section. Corner sections shall be of the same section modulus and metal as the regular sections.

When required, galvanizing shall meet ASTM A 525 Coating Designation G 210.

SECTION 844 STRUCTURAL TIMBER, LUMBER, AND HARDWARE

844.01 STRUCTURAL TIMBER AND LUMBER.

This material shall meet AASHTO M 168.

844.02 HARDWARE.

- A. **Timber Connectors.** The dimensions and types of all connectors shall be shown in the Contract. The materials for connectors shall be as follows:
1. Split Ring, Tooth Ring, and Shear Plate Connectors shall meet ASTM A 711.
 2. Spike Grid Connectors shall meet ASTM A 47, Grade 35018.
 3. All connectors, except those of malleable iron, shall be galvanized according to AASHTO M 111.
- B. **Hardware.** Bolts, rods, drift-bolts, and dowels may be either wrought iron or medium steel. Washers shall be made integral with the heads and nuts and their diameters shall be at least four times the diameter of the respective bolts. Hardware, nails, and spikes shall be galvanized according to AASHTO M 232.

SECTION 846 PRESERVATIVES AND PRESSURE TREATMENT PROCESSES FOR TIMBER

846.01 TIMBER PRESERVATIVES.

This material shall meet AASHTO M 133.

**SECTION 848
MASONRY UNITS AND BRICK**

848.01 MATERIALS.

- A. **Concrete Masonry Units for Construction of Catch Basins and Manholes**
 ASTM C 139
- B. **Building Brick (Made from Clay or Shale).** AASHTO M 114

**SECTION 852
PAINTS, OILS, AND THINNERS**

852.01 MATERIALS.

Paints, oils, and thinners shall meet the following:

- A. **Aluminum Paint.** AASHTO M 69
- B. **Lamp Black.** ASTM D 209
- C. **Chrome Yellow and Chrome Orange.** ASTM D 211
- D. **Enamels.** The enamel shall meet the general requirements of Federal Specifications TT-E-529 Enamel, Alkyd, Semi-Gloss (Class A Air-drying) with the following exceptions:
1. Alkyd resin shall be an alkyd meeting Federal Specification TT-R-266a Resin, Alkyd (Type I or Type II).
 2. Specular gloss, 60 degrees, shall be in the range of 40 to 70.

**SECTION 854
GALVANIZING**

854.01 GALVANIZING.

Galvanizing shall meet AASHTO M 111 or AASHTO M 232.

854.02 DAMAGED GALVANIZED COATINGS.

Repair of damaged galvanized coatings shall meet ASTM A 780.

**SECTION 856
EROSION CONTROL BLANKET AND
TURF REINFORCEMENT MAT**

856.01 EROSION CONTROL FABRIC.

The erosion control blanket (ECB) shall be of organic biodegradable mulch material such as straw, curled wood excelsior, coconut fiber, or any combination of these materials. The ECB shall have a consistent thickness of mulch material evenly distributed over the entire area. The ECB materials must be secured on at least one side with netting. The netting must be of photodegradable polypropylene or other plastic material fused to the strand intersections. The ECB shall be a minimum width of 48 inches and shall be weed and pest free.

- A. **Wood Excelsior Blanket.** The wood excelsior blanket shall consist of a machine-produced blanket of cured wood excelsior in which 80 percent of the fibers are 6 inches or longer. The wood excelsior blanket shall be smolder-resistant without using additives.
- B. **Straw Blanket.** The straw blanket shall consist of a machine-produced blanket of 100 percent certified weed-free agricultural straw by an accredited agency in which 80 percent of the fibers are 3 inches or longer.
- C. **Straw and Coconut Blanket.** The straw and coconut blanket shall consist of a machine-produced blanket of 70 percent straw and 30 percent coconut fibers by weight in which 80 percent of the fibers are 3 inches or longer.

**TABLE 856-1
EROSION CONTROL BLANKET**

TYPE	ECB 1		ECB 2		ECB 3		ECB 4	
	Straw	Wood	Straw	Wood	Straw/Coconut	Wood	Coconut	Wood
Material	100% Straw	100% Excelsior Fibers	100% Straw	100% Excelsior Fibers	70% Straw and 30% Coconut Fibers	100% Excelsior Fibers	100% Coconut Fibers	100% Excelsior Fibers
Fiber Length 80% Must Be Greater Than	3 inches	80% > 6 inches	3 inches	6 inches	3 inches	80% > 6 inches	3 inches	80% > 6 inches
Min Mass Per Unit Area ASTM D 6475	0.5 lbs/sy	0.51 lbs/sy	0.5 lbs/sy	0.51 lbs/sy	0.5 lbs/sy	0.69 lbs/sy	0.5 lbs/sy	0.88 lbs/sy
Min Thickness ASTM D 6525	0.25 inch	0.25 inch	0.25 inch	0.25 inch	0.25 inch	0.25 inch	0.25 inch	0.50 inch
Net Opening Minimum	0.5x0.5 inch	0.75x0.75 inch	0.5x0.5 inch	0.75x0.75 inch	0.5x0.5 inch	0.75x0.75 inch	0.6x0.6 inch	0.75x0.75 inch
Max Shear Stress @ 0.50 inches soil loss ASTM D 6460		1.50 lbs/sy	1.50 lbs/sy	1.75 lbs/sy	1.75 lbs/sy	2.0 lbs/sy	2.25 lbs/sy	2.25 lbs/sy
Slope Gradient Application	≤3H:1V	<3H:1V-2H:1V	≤2H:1V	2H:1V-1.5H:1V	≤1.5H:1V	≤1.5H:1V	≤1H:1V	≤1H:1V
Net Backing Type	Rapid Photodegradable Polypropylene		Polypropylene		Polypropylene		Black UV Stabilized Polypropylene	
Functional Longevity	≤ 3 months		≤ 12 months		12 to 24 months		> 24 months	
Min Machine Direction Tensile Strength ASTM D 6818	50 lbs/ft		75 lbs/ft		100 lbs/ft		125 lbs/ft	

The information in this table has been derived from information obtained from the Erosion Control Technology Council. All values must be with 10 percent of the minimums shown on the table.

856.02 TURF REINFORCEMENT MAT.

The turf reinforcement mat (TRM) shall be three dimensional structure of entangled filaments. The filaments shall either be bonded by heat fusion and the intersections or stitched with polypropylene, a nylon or polyester threads between two UV-Stabilized nettings. The TRM shall be resistant to biological, chemical, environmental, and ultra-violet degradation. The TRM shall promote and maintain the integrity of the grass root system.

**TABLE 856-2
TURF REINFORCEMENT MAT**

TYPE	TRM 1	TRM 2
Matrix Fill Material	Wood Excelsior, Coconut or Polymer Fibers	100% Stabilized Polypropylene Fibers
Min Mass Unit Area ASTM D 6475 (natural fibers) 6566 (synthetics)	0.625 lbs/sy	0.625 lbs/sy
Minimum Thickness ASTM D 6525	0.25 inch	0.5 inch
Minimum Roll Width	6.5 ft	6.5 ft
Size of Net Opening	0.5 × 0.5 inch	0.5 × 0.5 inch
Max Shear Stress @ 0.50 inches soil loss ASTM D 6460, under vegetated conditions	6.0 lbs/sf	8.0 lbs/sf
Minimum Tensile Strength ASTM D 6818	125 lbs/ft	150 lbs/ft

856.03 STAPLES.

Staples for ECM and TRM shall be constructed of 11 gauge or heavier steel wire and shall be either U-shaped measuring at least 1 inch across the top and at least 8 inches along each leg, or shall be T-shaped measuring at least 4 inches across the top and at least 8 inches in length.

856.04 FABRIC FORMED SLOPE PROTECTION.

Fabric forming material shall consist of specially woven, double-layer, open salvage fabric joined in a mat configuration. The fabric shall consist of uncoated synthetic yarns with sufficient tensile strength and porosity to withstand the pressure of the grout injection pump without breaking the layers of fabric.

Spacer threads capable of a tensile strength of at least 8.0 psi of surface area shall be woven between the layers at the required distance to control the mat thickness.

SECTION 858 GEOTEXTILE FABRICS

858.01 GENERAL.

Geotextile fabric shall be a fabric consisting of polymeric filament or yarns such as polypropylene, polyethylene, polyester, polyamide, or polyvinylidene chloride. The filaments or yarns shall be formed into a stable network so they retain their relative position to each other. The geotextile shall be inert to commonly encountered chemicals and meet the properties in the following table:

A. Geotextile Fabrics.

Geotextile Property	Test Method	GEOTEXTILE FABRIC TYPE								
		Separation ⁽²⁾		Drains				Riprap	Reinforcement	
		S1	S2	D1	D2	D3 ⁽³⁾	D4 ⁽³⁾	RR	R1	R2 ⁽⁴⁾
Grab Tensile Strength ⁽¹⁾ , lbs., min.	ASTM D 4632	180	180	180	80	100	N/A	200	N/A	-
Grab Tensile Elongation, %, min.	ASTM D 4632	N/A	N/A	N/A	N/A	N/A	N/A	15	N/A	-
Grab Tensile Strength ⁽¹⁾ , lbs./in., min., Wide-Width Method	ASTM D 4595	N/A	N/A	N/A	N/A	N/A	N/A	N/A	270	-
Grab Tensile Elongation, % max.	ASTM D 4595	N/A	N/A	N/A	N/A	N/A	N/A	N/A	15	-
Trapezoid Tear Strength, lbs., min. (any direction)	ASTM D 4533	50	50	50	25	N/A	N/A	50	100	-
Puncture Strength lbs., min.	ASTM D 4833	75	75	80	25	N/A	N/A	80	100	-
AOS less than mm, (greater than US STD. Sieve)	ASTM D 4751	0.212 (70)	0.150 (100)	0.300 (50)	0.150 (100)	0.125-0.425 (40-120)	0.125-0.425 (40-120)	0.300 (50)	0.600 (30)	-
Permittivity, sec. ⁻¹ , min.	ASTM D 4491	0.10	0.05	0.50	0.05	0.70	1.0 relaxed	0.20	0.05	-
UV Resistance (After 150 hrs.) % Strength Retained	ASTM D 4355	70	70	70	70	70	N/A	70	70	-
Weight oz/sy		N/A	N/A	N/A	N/A	N/A	3.5	N/A	N/A	-
Sewn-Seam Strength, lbs.	ASTM D 4632	160	160	160	70	90	N/A	180	N/A	-
Sewn-Seam Strength, lbs/in.	ASTM D 4884	N/A	N/A	N/A	N/A	N/A	N/A	N/A	240	-

(All values represent minimum roll values. Test results from any sample shall meet or exceed the minimum values listed.)

- (1) Weakest principal direction.
- (2) Separation Fabrics shall be nonwoven fabrics.
- (3) Type D3 and D4 fabric will only be used as a geotextile fabric sock. The type D4 fabric will be knit of 150 denier (min.) polyester yarn, exhibit minimum snag or "run" potential, be factory-applied to maintain a uniform installed weight, and conform to the outside diameter of the pipe with a snug fit throughout.
- (4) Properties will be specified by Plan Note.

- B. **Concrete Curing Fabric.** The concrete curing fabric shall be a highly absorbent fabric made from a light colored nonwoven material that weighs a minimum of eight ounces per square yard.

SECTION 860 FENCE

860.01 CHAIN LINK FENCE.

This material shall meet AASHTO M 181.

860.02 BARBED WIRE, WOVEN WIRE, AND STAPLES.

- A. **Barbed Wire.** Barbed wire shall meet ASTM A 121, Class 1. Brace wire and loops shall be No. 9 gauge smooth galvanized wire.
- B. **Woven Wire.** Woven wire shall meet ASTM A 116, Class 1.
- C. **Staples.** Staples shall be 1-1/2 inches long and made of No. 9 gauge galvanized wire.

860.03 STEEL POSTS.

- A. **Line Posts.** Line posts shall meet the details shown on the Plans and the following requirements:

Posts shall be galvanized and meet ASTM A 702, Type B steel.

Wire fasteners shall be furnished with each post. They shall be made of galvanized wire and shall securely fasten the wire to the posts.

Each post shall have rolled in corrugations, ribs, lugs or notches so constructed as to engage the fence wires in proper position. Posts with punched tabs intended to be crimped around the wires shall not be accepted.

- B. **Angle-Type End, Corner, and Pull Posts.** Angle-type end, corner, and pull posts shall have a nominal weight of 4.10 pounds per foot. Angles for braces shall have a nominal weight of 3.19 pounds per foot. Posts shall not weigh less than 97 percent of the specified weight.

860.04 WOOD POSTS.

Wood posts shall be of Pine, Fir, Spruce, Cedar, Aspen, American Elm, Eastern Cottonwood, or Ash. Posts shall be naturally round and shall be cut from live, green growing trees.

Line Posts and braces shall be at least 3-1/2 inches in diameter at the small end and of the length shown on the Plans. Corner and brace posts shall be of length and diameter shown in the Contract. Posts shall be Plan length \pm 1 inch.

All posts shall have the inner bark shaved off, knots trimmed and be pointed for driving before treatment.

Knots that are sound, smoothly trimmed, and do not impair the strength of the posts will be permitted. Decay, short kinks, and reverse bends will not be permitted. One way sweep not to exceed 1-1/2 inches will be permitted.

Defects of any kind which give the posts an unsightly appearance will not be permitted.

All posts shall be preserved and treated according to Section 846.

SECTION 862 GUARDRAIL AND POSTS

862.01 GENERAL.

All steel components of the various types of guardrail shall be galvanized.

No burning, cutting, or welding will be permitted after galvanizing unless the item is regalvanized according to Section 854.

862.02 WIRE ROPE AND FITTINGS FOR CABLE GUARDRAIL.

Wire rope and connecting hardware shall meet AASHTO M 30, Type I, Class A, 3/4-inch rope. Connecting hardware shall develop the full strength of a single cable (25,000 pounds). Cast steel components shall meet AASHTO M 103.

- A. **Socket Baskets and Wedges.** Socket baskets shall be designed for use with the wedge detailed on the Plans.
- B. **Threading.** Threads of externally-threaded parts shall be UNC, ANSI B1.1, Class 2A Tolerance. Internally-threaded parts shall meet the dimensional requirements of ASTM A 563.
- C. **Bolts, Nuts, and Washers.** Bolts shall meet ASTM A 307 and nuts to ASTM A 563, Grade A, or better. Both nuts and bolts shall be galvanized according to AASHTO M 232. Nuts shall be hex or heavy hex type.

Hook bolts, as installed, shall develop an ultimate pull open strength of from 500 to 1,000 pounds applied in a direction normal to the longitudinal axis of the post.

Washers shall be made of steel and shall be galvanized according to AASHTO M 232. They shall meet the dimensional requirements of ANSI B27.2, Type A plain washer.

- D. **Washer Plates.** End and line post washer plates shall meet AASHTO M 183 and shall be galvanized according to AASHTO M 111.
- E. **Substitutes.** Alternate hardware design will be considered for approval provided the connection details are compatible with the details in the Contract and the operational characteristics are similar to those of the hardware specified.

862.03 GUARDRAIL UNITS AND FITTINGS FOR W-BEAM GUARDRAIL.

W-Beam guardrail units, backup plates, flared end sections, and buffer end sections shall meet AASHTO M 180, Class A, Type 2. The terminal connector shall meet AASHTO M 180, Class B, Type 2.

- A. **Button Headed Bolts and Hex Bolts.** The 5/8-inch button headed bolts and hex bolts shall meet ASTM A 307 and nuts to ASTM A 563, Grade A or better. They shall be galvanized according to AASHTO M 232.
- B. **Plates.** The rectangular plate washers shall meet AASHTO M 180. Break-away cable treatment (BCT), cable end plates, bearing plates (timber), and anchor plates shall meet AASHTO M 180 and shall be galvanized according to AASHTO M 111.
- C. **Washers.** Washers shall be made of steel and shall be galvanized according to AASHTO M 232. They shall meet the dimensional requirements of ANSI B27.2, Type A plain washers.
- D. **Break-Away Cable Terminal Assembly.** The swaged fitting shall be machined from hot-rolled carbon steel meeting ASTM A 576, Grade 1035, and shall be annealed suitable for cold swaging. The swaged fitting shall be galvanized according to AASHTO M 111 before swaging. A lock pin hole to accommodate a 1/4-inch plated, spring steel pin shall be drilled through the head of the swage fitting to retain the stud in the proper position. After galvanization the head may be tapped 0.023 inch over the ANSI Class 2B Tolerance.

The stud shall meet ASTM A 449 and shall be galvanized according to AASHTO M 232. The threads shall be ANSI Class 2A fit before galvanizing. Before galvanizing, a 3/8-inch slot for the locking pins shall be milled into the stud end.

The wire rope shall meet AASHTO M 30 and shall be 3/4-inch preformed, 6 × 19, wire strand core or independent wire rope core (IWRC), galvanized, right regular lay, manufactured of improved plow steel, with a minimum breaking strength of 42,800 pounds. A galvanized rod type assembly may be substituted with a minimum breaking strength as specified.

The swaged fitting, stud, and nut shall develop the breaking strength of the wire rope.

The one-inch nut shall meet AASHTO M 164 and washers shall be made of steel; both shall be galvanized according to AASHTO M 232. After galvanizing, the pitch diameter of the nut may be tapped 0.023 inch over the ANSI Class 2B Toler-

ance. Washers shall meet the dimensional requirements of ANSI B27.2, Type A plain washers.

- H. **W-Beam Guardrail End Treatments.** W-beam Guardrail End Treatments shall meet the requirements of the National Cooperative Highway Research Program (NCHRP) Report 350, Test Level 3. The W-Beam Guardrail End Treatments shall be one of the types shown in the Plans.

The impact head shall be capable of flattening, cutting, kinking or bending the guardrail away from the impacting vehicle. The impact head shall be attached to the first post by two 3/8 inch lag screws as specified by the supplier. The first post and second post shall be installed in a galvanized steel foundation tube. A break-away cable assembly shall be anchored to the guardrail as shown in the plans. The remaining posts shall be break away posts and standard line posts as shown in the plans. The guardrail elements shall be of the lengths shown on the plans and be 12 gage sections as specified in AASHTO M 180. The timber posts shall meet requirements for materials that passed the crash testing.

862.04 TREATED WOOD GUARDRAIL POSTS.

The timber used for treated wood posts for beam guardrail shall be made from timber with a stress grade of 1,200 psi or more. Testing shall be according to West Coast Lumber Inspection Bureau, Southern Pine Inspection Bureau, or another appropriate timber association. Rectangular timber posts and offset blocks shall be either rough sawn (unplaned) or S4S with nominal dimensions shown in the Contract. The size tolerance of rough sawn blocks in the directions of the bolt holes shall be not more than $\pm 1/4$ inch, and shall meet the requirements of the treated timber guardrail posts. Round treated timber posts used with W-Beam shall be 8-3/4 inches in diameter \pm one inch. Round posts shall be notched to receive wooden offset blocks before treatment. The notched flat surface shall be 5 to 6 inches wide and 14 to 15 inches long, or shall extend to the full length of the post. The minimum depth of the remaining post material, after notching, shall be 6-3/4 inches. Round posts may have a domed top in lieu of a flat top.

Round treated timber posts used with three-cable guardrail shall be 5-1/2 inches in diameter \pm one inch and are required to be made from timber with a stress grade of 1,200 psi or more.

- A. **Quality.** The quality of all posts shall be governed by the following requirements:
1. No decay will be permitted.
 2. Knots will be permitted if they are sound and smoothly-trimmed, and if they plainly do not impair the post's strength.
 3. Checks wider than 1/4 inch or deeper than 3 inches will not be permitted.
 4. One way sweep shall not exceed 1-1/2 inches.
 5. Winding twist will be permitted unless exaggerated and unsightly.
 6. Short kinks will not be permitted.
 7. Defects of any kind which give the post an unsightly appearance will be sufficient cause for rejection.

- B. **Peeling and Trimming.** Round timber posts shall have all the inner bark shaved off and knots closely trimmed before treatment.
- C. **Preservative Treatment.** The preservative shall meet Section 846. All posts on the Project shall have the same treatment. Timber offset blocks shall be treated.

862.05 STEEL GUARDRAIL POST.

Steel posts, adjustment blocks, blockouts, attachment angles, and base plates shall meet AASHTO 270 Grade 36 and shall be galvanized after fabrication according to AASHTO M 111. Welding shall meet the current AWS D1.1.

862.06 BOX BEAM.

Box beam post and rail shall be structural tubing. Post base plates and splice tongues and plates shall meet AASHTO 270 Grade 36 structural steel. Rail shall meet ASTM A 500 cold-formed, welded, and seamless carbon steel structural tubing in rounds and shapes, Grade 1B, modified as follows:

- A. **Rail Tests.** All rail shall be tested according to ASTM E 436 modified as follows:
 1. Tests shall be conducted after all galvanizing and associated operations have been completed on the rail. The testing shall be conducted at a temperature of 0°F. (-18°C.) on galvanized specimens two inches by seven inches in size, supported to span 7 inches. Galvanizing shall not be removed from galvanized rail specimens.
 2. The percent shear area will be determined by tests on nine specimens, three from each of the three sides not containing a weld. The shear areas of the three specimens from the side with the lowest average shear area will be disregarded and the final average based on the remaining six specimens. The material represented by these specimens will be rejected if the average percent shear area is less than 50 percent.
 3. No mill transverse weld will be permitted on the rail sections. Longitudinal welds shall be made by the resistance weld process, shall be sound, free from defects, and shall not be repaired. Rail elements to be used in curves having a radii of 175 feet or less shall be shop formed to the required curvature.
 4. Before galvanizing the rail material, the manufacturer shall identify the rail to facilitate acceptance of the material. Identification shall be by heat number or some number used to identify heat number and the manufacturers unique coding. This identification shall be readable after galvanizing and shall be placed on the rail at 4-foot intervals.
- B. **Splice Plates and Expansion Plates.** The splice plates and expansion plates shall meet AASHTO 270 Grade 36. Nuts shall meet ASTM A 563, Grade A or better, and the plates with nuts attached shall be galvanized according to AASHTO M 111.
- C. **Bolts, Nuts, and Washers.** Bolts shall meet ASTM A 307 and nuts to ASTM A 563, Grade A or better, and be galvanized according to AASHTO M 232. Bolts

and nuts shall be the hex and heavy types. Washers shall be made and shall be galvanized according to AASHTO M 232. Washers shall meet the dimensional requirements of ANSI B27.2, Type A Plain Washers.

- D. **Certification.** Each box beam and box beam median barrier for a project shall be accompanied by certified test results of actual tests for the heat of base metal used in fabricating all rails, posts, base plates, splice plates, expansion plates, blockouts, and attachment angles in the shipment. Certified test results of actual tests performed to determine compliance with the galvanizing requirements of this Specification, are also required on component parts of the shipment.
- E. **Galvanizing.** The posts, bases, splice plates, expansion plates, blockouts, and attachment angles shall be fabricated and ready for assembly before galvanizing. Slots and round holes may be subsequently drilled, punched, burned or cut after galvanizing, and regalvanized according to Section 854.

SECTION 868 INSULATION BOARD (POLYSTYRENE)

868.01 REQUIREMENTS.

Insulation Board (polystyrene) shall meet AASHTO M 230.

SECTION 880 PAVEMENT MARKINGS

880.01 PAVEMENT MARKING PAINT.

A. General.

1. **Quality.** All paint shall be formulated from first grade materials and shall be suitable in all respects for application at elevated spray temperatures with drop-on glass beads using conventional traffic striping equipment. The finished paint shall be smooth and homogeneous, free of coarse particles, skins or any other foreign materials that are detrimental to its use or appearance.
2. **Manufacturing and Packaging of Preapproved Paint.** Unless the project quantities are less than 1,000 gallons, the paint shall be manufactured in lot sizes no smaller than 1,000 gallons. If the Project quantities are less than

1,000 gallons, the entire project quantity shall be manufactured in one lot. The paint shall be screened with a 40 mesh or finer screen to remove any coarse particles, skins or foreign materials. Paint shall be packaged in a container coated with a non-corrosive lining. The outside coating, for drums containing water-based paints, shall be a pastel color. The storage temperature shall be kept at 32°F. or higher.

3. **Package Stability of Preapproved Paint.** Within a period of 12 months from the time of delivery, the paint shall not cake, settle, liver, thicken, skin, curdle, gel or show any other objectionable properties which cannot readily be corrected with minimal stirring. Any paint with properties that make it unsuitable for use within the specified 12 months shall be rejected and replaced with paint that meets the Specifications. All costs incurred in replacing the paint shall be at the Contractor's expense.

- B. **Specific Requirements for Solvent-Based Traffic Marking Paint.** Solvent-based pavement marking paint shall meet the general requirements of AASHTO M 248-86: "Ready Mixed White and Yellow Traffic Paints" except for the following requirements:

AASHTO M 248-86, Section 4.1.2 shall be revised as follows:

ASTM D476 Type I Anatase, or Type II Rutile shall be used.

AASHTO M 248-86, Section 5.2.1, Extracted Pigment Requirements, shall be revised as follows:

The minimum purity requirements for the respective materials shall be as given in Sections 4.1.1 through 4.1.5.

Composition of Solvent-Based Paint White Traffic Paint

Low VOC Pigment Ingredients Type F	(% of Pigment)
Titanium Dioxide, Min.(Pure)	17.5
Calcium Carbonate	35.0-40.0
Magnesium Silicate	35.0-43.0
Zinc Oxide, Min.	3.0

Composition of Solvent-Based Paint Yellow Traffic Paint

Low VOC Pigment Ingredients Type F	(% of Pigment)
Lead Chromate, Min. (Pure)	16.7
Calcium Carbonate	35.0-40.0
Magnesium Silicate	35.0-43.0

AASHTO M 248-86, Section 5.3 shall be revised as follows:

**Composition of Non-Volatile Vehicle
White and Yellow Traffic Paint**

Vehicle Ingredients	Acrylic Copolymer Type F (% of Wt. of Vehicle)	Chlorinated Rubber Type F (% of Wt. of Vehicle)
Alkyd Resin Solids (±0.5%)	41.14	37.6
Acrylic Copolymer BR-201 or equivalent (±0.5%)	47.25	—
Chlorinated Rubber (±0.5%)	—	37.0
Chlorinated Paraffin (±0.5%)	11.61	25.4

AASHTO M 248-86, Section 5.4 shall be revised as follows:

Quantitative Requirements of White Solvent-Based Paint

Characteristics	Low VOC Type F
Titanium Dioxide (as % of Extr. Pigment) (min) (Pure)	17.5
Pigment (%)	49.0-51.0
Total Solids (%) (min)	69.0
Vehicle Solids (%) (min)	38.0
Weight per Gallon (lbs) (min)	11.1
Viscosity (K.U.)	70-85
Fineness of Grind (Hegman) (min)	2.0
Drying Time (Minutes) (max)	10.0
Directional Reflectance, (%) (min)	80
Uncombined Water (%) (max)	1.0
Particles and Skins Retained on 325 Mesh Sieve (%) (max)	1.0
Volatile Organic Content (lb/gal) (max)	1.25

Quantitative Requirements of Yellow Paint

Characteristics	Low VOC Type F
Lead Chromate (as % of Extr. Pigment) (min) (Pure)	16.7
Pigment (%)	50.0-52.0
Total Solids (%) (min)	69.5

Vehicle Solids (%) (min)	38.0
Weight per Gallon (lbs) (min)	11.3
Viscosity (K.U.)	70-85
Fineness of Grind (Hegman) (min)	2.0
Drying Time (Minutes) (max)	10.0
Color (to pass Fed. Std.) (Chip #33538)	
Directional Reflectance, (%) (min)	50
Uncombined Water (%) (max)	1.0
Particles and Skins Retained on 325 Mesh Sieve (%) (max)	1.0
Volatile Organic Content (^{lb} /gal) (max)	1.25

C. **Specific Requirements for Water-Based Traffic Marking Paint.** Acrylic waterborne pavement marking paint shall be capable of receiving and holding glass beads for producing retroreflective pavement marking. The paint shall contain no more than 3200 ppm lead nor more than 800 ppm chromium, based on dry weight. The finished paint shall be formulated and manufactured from quality material and shall be a fast-drying, water-based, acrylic resin-type paint capable of withstanding air and roadway temperatures without bleeding, staining, discoloring or deforming. The dried paint film shall be capable of maintaining original dimensions and placement without chipping, spalling or cracking. The dry paint film shall not deteriorate from contact with normal roadway chemicals or materials. The acrylic emulsion polymer used in the manufacture of the paint shall be Rohm & Haas HD-21, Dow DT400 or approved equal.

1. **Durability Testing.** Determination of conformance to this Specification will include, but will not be limited to, the evaluation of test data from NTPEP or other Department-approved facilities. The maintained retroreflectivity and durability shall be in accordance with the following requirements after being installed on at least one NTPEP test deck in a northern, wet climate region for a minimum of six months, including December, January, and February.
2. **Maintained Retroreflectivity.** Photometric quantity to be measured will be the coefficient of retroreflective luminance (RL) in accordance with the requirements of ASTM E 1710 for 30-meter geometry. The average RL for concrete and bituminous surfaces shall be expressed in millicandelas per foot candle per square foot and shall be at least 75 for 30-meter geometry, when measured in the wheel path area.
3. **Durability.** Paint shall have a durability rating of at least four for both concrete and bituminous surfaces when tested in the wheel path area of the NTPEP test deck.
4. **Mixed Paint.**
 - a. The paint shall be strained before filling using a screen or a sieving device no coarser than 40 mesh or equivalent.
 - b. The volatile content of the finished paint shall contain less than 150 grams of volatile organic matter per liter in accordance with ASTM D 3960.

- c. The paint shall have the following physical properties:

Acrylic Waterborne Pavement Marking Paint Physical Properties

Property	Requirement
Viscosity, 77°F. (25°C.) KU	83-98
Grind (Hegman Gage), minimum	3
Laboratory Dry Time, ASTM D 711, @ 15 mil, minutes, max.	10
Dry Through Time, minutes, max.	150

5. **Color.** For white, the color shall closely match Color Chip 37925 of Federal Standard 595b. For yellow, the color shall closely match Color Chip 33538 of Federal Standard 595b. Color determination will be made for markings and the diffuse daytime color of the markings shall be in accordance with the below CIE Chromaticity coordinate limits. Color determination for liquid marking material will be made over the black portion of a 2A or 5C Leneta Chart or equal, at least 24 hours after application of a 15-mil wet film. Color readings will be determined in accordance with the requirements of ASTM E 1349 using CIE 1931 2-degree standard observer and CIE standard illuminant D65.

CIE Chromaticity Coordinate Limits (Initial)

Color	1		2		3		4	
	x	y	x	y	x	y	x	y
White	0.334	0.357	0.334	0.317	0.297	0.357	0.297	0.317
Yellow	0.531	0.483	0.531	0.429	0.471	0.483	0.471	0.429

6. **Flexibility.** The paint shall show no cracking or flaking when tested in accordance with Federal Specification TT-P-1952B.
7. **Water Resistance.** The paint shall conform to Federal Specification TT-P-1952B. There shall be no blistering or appreciable loss of adhesion, softening or other deterioration after examination.
8. **Freeze-Thaw Stability.** The paint shall show no coagulation or change in consistency greater than 10 Kreb Units when tested in accordance with Federal Specification TT-P-1952B.
9. **Heat Stability.** The paint shall show no coagulation, discoloration or change in consistency greater than 10 Kreb Units when tested in accordance with Federal Specification TT-P-1952B.
10. **Dilution Test.** The paint shall be capable of dilution with water at all levels without curdling or precipitation such that the wet paint can be readily cleaned up with water only.
11. **Storage Stability.** After 30 days of storage in a 3/4 filled, closed container, the paint shall show no caking that cannot be readily remixed to a smooth, homogeneous state, and shall show no skinning, livering, curdling or hard

settling. The viscosity shall change no more than 5 Krieb Units from the viscosity of the original sample.

12. **Contrast Ratio.** The minimum contrast ratio (hiding power) shall be 0.96 when drawn down with a 0.005 mil film applicator on a 2A or 5C Leneta Chart or equal and air-dried for 24 hours. The contrast ratio shall be calculated as follows:

$$\text{Contrast Ratio} = \text{Black/White}$$

13. **Reflectance.** The daylight directional reflectance of a 15-mil (380 μm) wet film, applied to a 2A or 5C Leneta Chart or equal and dried for a minimum of 24 hours, shall be no less than 84 percent for the white paint and no less than 50 percent for the yellow paint.
14. **Bleeding.** The paint shall have a minimum bleeding ratio of 0.97 when tested in accordance with Federal Specification TT-P-1952B. The asphalt saturated felt shall be in accordance with ASTM D 226 for Type I.
15. **Dry Through Time.** The paint shall be applied to a non-absorbent substrate at a wet film thickness of 15 ± 1 mil and placed in a humidity chamber controlled at 90 ± 5 percent relative humidity and 72.5 ± 2.5 F (22.5 ± 1.4 C). The dry through time shall be determined in accordance with ASTM D 1640, except that the pressure exerted shall be the minimum needed to maintain contact with the thumb and film.
16. **Acceptance.**
- a. When preapproval of pavement marking paint, solvent or water based, is specified, the Contractor shall obtain two, 1-pint samples of paint from each lot after the paint has been shipped to some point acceptable to the Engineer. Epoxy lined cans shall be used for sampling water based paint. Department personnel are to be notified and shall be present when each sample is obtained. The Department personnel will submit the samples to the Department's Materials and Research Division. The samples shall be submitted 30 days before the scheduled use of the marking paint. If the paint sample meets Specifications, the lot being represented by the sample will be accepted. If a paint sample fails to meet Specifications, the lot being represented by the sample will be rejected and replaced with paint that meets Specifications. All costs incurred in replacing non-specification paint shall be at the Contractor's expense.
 - b. If preapproval of the marking paint, solvent or water based, is not specified, the Department will take random samples of the marking paint. If the paint samples meet Specifications, the lot being represented by the sample will be accepted. If the paint does not meet the Specifications and the paint has not been applied to the road, the paint will be rejected and replaced with paint that meets Specifications. If the paint sample does not meet Specifications and the paint has been applied to the road, and the work is found unacceptable, the lot being represented by the sample will be rejected and replaced with paint that meets Specifications. All costs incurred in replacing non-specification paint shall be at the Contractor's expense.

- c. No paint shall be used that is more than 15 months old.
- d. In addition to the requirements of this section, the certification supplied by the manufacturer shall include reference to the specific NTPEP test deck to which the paint formulation was applied, including NTPEP identification numbers and report numbers.

880.02 GLASS BEADS.

A. Specific Requirement.

1. Glass Beads for Solvent-Based Paint.

- a. **Physical Properties.** Glass beads for solvent-based pavement marking paint shall meet AASHTO M 247, Type I. The flotation properties of AASHTO M 247 shall be modified to allow a maximum of 20 percent of the beads, by weight, to float when tested according to Section 4.5.
- b. **Sampling and Testing.** The sampling and testing shall be according to AASHTO M 247.

2. Glass Beads for Water-Based Paint.

- a. **Physical Properties.** Glass beads for pavement marking shall meet AASHTO M 247, Type I, "standard gradation," except the beads shall have a minimum of 80 percent true spheres. The beads shall be made from clean colorless transparent glass and shall be smooth, spherically shaped, and free from milkiness, pits, excessive air bubbles, chips, and foreign material. The beads shall have a dual surface treatment consisting of a moisture resistant silicone treatment and a silane adherence surface treatment.
- b. **Sampling and Testing.** The sampling and testing shall be according to the Department's *Field Sampling and Testing Manual*.

B. **Packaging and Marking.** The beads shall be furnished in moisture proof containers or moisture proof bags. Each container or bag shall be marked with name of contents, manufacturer, net weight, lot number, and ton number.

C. **Certification.** The manufacturer shall furnish one copy of a certificate for each lot of the material furnished, giving the properties of the beads and certifying that they meet the required Specifications. The affidavit shall show designation of the sample, lot number, and date of manufacture.

880.03 PLASTIC PAVEMENT MARKING FILM (RETROREFLECTIVE).

A. **General.** The prefabricated plastic pavement markings shall consist of white or yellow pigmented plastic films, conforming to standard highway colors, with reflective glass spheres incorporated throughout the entire cross-sectional area and a layer of reflective glass spheres bonded to the top surface. The pavement markings shall adhere to bituminous or Portland Cement Concrete pavements by either a pressure-sensitive precoated adhesive or a liquid contact cement. The markings

shall be provided in a form that facilitates rapid application and protects the markings in shipment and storage. The manufacturer shall identify proper solvents and adhesives to be applied at the time of application, all equipment necessary for proper application, and recommendations for application that assures an effective performance life. The marking material shall mold itself to pavement contours by the action of traffic. The pavement marking films shall also be capable of application on new bituminous concrete wearing courses during the paving operation according to the manufacturer's instructions. After application, the markings shall be immediately ready for traffic.

Prefabricated legend and symbols shall meet the applicable shapes and sizes shown in the Contract.

- B. **Retroreflective Pliant Polymer.** The pavement marking film shall consist of a mixture of high quality polymeric material, pigments, 1.5 index glass beads uniformly distributed throughout its cross-sectional area, and a reflective layer of beads bonded to the top surface. These materials shall be as follows:

Materials	Minimum Percent by Weight
Resins & Plasticizers	20
Pigments	30
Graded Glass Beads	33

The remaining 17 percent shall be comprised of the above materials in various proportions.

These materials shall be fabricated into pavement marking film of specified thickness and dimensions.

C. **Requirements.**

1. **Skid Resistance.** The surface of the marking film shall provide a minimum skid resistance value of 45 BPN when tested according to ASTM E 303.
2. **Reflectance.** The white and yellow films shall have the initial minimum values specified in the following table when measured according to ASTM D 4061. The photometric quantity to be measured shall be specific luminance (SL), and shall be expressed as millicandelas per square foot per foot candle [(mcd/ft²)/fc]. The metric equivalent shall be expressed as millicandelas per square meter per lux. The sample size shall be a 2 feet by 2.5 feet rectangle.

<u>Observation Angle</u>	White		Yellow	
	<u>0.2°</u>	<u>0.5°</u>	<u>0.2°</u>	<u>0.5°</u>
SL [(mcd/ft ²)/fc]	550	380	410	250

3. **Tensile Strength and Elongation.** The film shall have a minimum tensile strength of 150 psi of cross-section when tested according to ASTM D 638. A sample 6 inches by 1 inch shall be tested at a temperature between 70°F and 80°F using a jaw speed of 12 inches per minute. The film shall have a minimum elongation of 75 percent at break.
4. **Patchability.** The pavement marking film shall be capable of use for patching worn areas of the same type of film according to the manufacturer's instructions.

5. **Pigmentation.** The film, white or yellow, shall meet standard highway colors.
6. **Acid Resistance.** The beads shall show resistance to corrosion of their surface after exposure to a 1 percent solution (by weight) of sulfuric acid. The 1 percent acid solution shall be made by adding 5.7 cc of concentrated acid into 1,000 cc of distilled water. Always add the concentrated acid into the water, not the reverse. The test shall be performed as follows:

A 1-inch by 2-inch sample shall be adhered to the bottom of a glass tray and just enough acid solution shall be placed over the sample to completely immerse it. The tray shall be covered with a piece of glass to prevent evaporation and the sample shall remain under those conditions for 24 hours. The acid solution shall be decanted and the sample, while adhering to the glass tray, shall be dried in a 150°F. oven for approximately 15 minutes.

Microscopic examination with 20 power shall show no more than 15 percent of the beads having a formation of a very distinct opaque white (corroded) layer on their entire surface.
7. **Reflective Retention.** To have effective performance life, the glass beads shall be strongly bonded. One of the following tests shall be employed to measure reflective retention:
 - a. **Taber Abrader Simulation Test.** Using a taber abrader with an H-18 wheel and a 125-gram load, the sample shall be inspected at 200 cycles under a microscope and no more than 15 percent of the beads shall be lost due to popouts.
 - b. **Qualitative Tests.** Bead bond strengths shall be judged under a microscope with a magnification of at least five power. The beads shall be difficult to remove and bead removal shall remove a portion of the polymeric bead bond with the bead rather than popping out clean from their sockets.
8. **Thickness.** The film, without adhesive, shall be supplied in a standard thickness of 0.06 inch.
9. **Effective Performance Life.** The film, when applied according to the manufacturer, shall provide a neat, durable marking that will not flow or distort due to temperature. Although reflectivity is reduced by wear, the film shall provide a cushioned resilient substrate that reduces bead crushing and loss. The film shall be weather resistant and through normal traffic wear, shall not fade, lift, or shrink throughout the life of the marking and shall show no significant tearing, roll back, or other signs of poor adhesion.

880.04 PREFORMED PLASTIC MARKING FILM.

- A. **General.** The pavement marking material shall consist of white or yellow weather-resistant reflective film meeting the following requirements:

The markings shall be manufactured and packaged to permit storage at the manufacturer's recommended shelf temperature for a period of not less than one year from the date of purchase.

Prefabricated legends and symbols shall meet the shapes and sizes as shown on the Standard Drawings.

- B. **Composition.** The preformed plastic markings shall consist of high quality plastic material, pigments, and 1.5 index glass beads uniformly distributed throughout its cross sectional area and with a reflective layer of beads embedded or bonded in the top surface. The film shall be furnished with the appropriate adhesive system recommended by the manufacturer.
- C. **Skid Resistance.** The surface of the preformed plastic marking film shall provide an initial skid resistance value of 55 BPN and a retained skid resistance value of 35 BPN when tested according to ASTM E 303.
- D. **Color.** The striping material shall be white or yellow in color meeting standard highway colors.
- E. **Thickness.** The thickness of the preformed plastic marking film without adhesive shall be 60 mils.
- F. **Durability and Wear Resistance.** The preformed plastic marking film, when properly applied, shall provide a neat, durable marking. The preformed plastic marking film shall provide a cushioned resilient surface substrate that reduces bead crush and loss. The film shall be weather resistant and through normal traffic wear shall not fade, lift, or shrink throughout the life of the marking, and show no significant tearing, roll back, or other signs of poor adhesion.
- G. **Tensile Strength.** The film shall have a minimum tensile strength of 40 psi of cross section when tested according to ASTM D 638.
- H. **Conformability and Resealing.** The preformed film shall conform to pavement contours, breaks, faults, etc., through the action of traffic at normal pavement temperatures. The film shall have resealing characteristics that will fuse with itself and previously-applied marking film of the same composition under normal conditions of use.
- I. **Elongation.** The film shall have a maximum elongation of 100 percent when tested according to ASTM D 638.
- J. **Plastic Pull Test.** A test specimen one inch by 3 inches shall support a dead weight of 5 pounds for not less than five minutes at a temperature between 70°F. and 80°F.

880.05 PREFORMED PATTERNED PAVEMENT MARKING FILM.

- A. **General.** The preformed patterned markings shall consist of white or yellow films with ceramic beads incorporated to provide immediate and continuing retro-reflection and shall meet the following requirements:

The markings shall be manufactured and packaged to permit storage at manufacturer's recommended shelf temperature for a period of not less than one year from the date of purchase.

Legends and symbols shall conform to the shapes and sizes as shown on the Standard Drawings.

The Contractor shall secure from the manufacturer all warranties and guarantees with respect to materials, workmanship, or performance which the products covered by the proposal bear, and include these warranties and guarantees with the certification.

- B. **Composition.** The retroreflective pliant polymer pavement markings shall consist of a mixture of high quality polymeric materials, pigments and glass beads distributed throughout its base cross-sectional area, with a reflective layer of ceramic beads bonded to a durable polyurethane topcoat surface. The patterned surface shall have approximately 50 percent ± 15 percent of the surface area raised and presenting a near vertical face to traffic from any direction. The channels between the raised areas shall be substantially free of exposed beads or particles.

The preformed markings shall conform to pavement contours by the action of traffic. The pavements markings shall be capable of application on new, dense, and open graded asphalt wearing courses during the paving operation according to the manufacturer’s instructions. After application, the marking shall be immediately ready for traffic.

- C. **Skid Resistance.** The surface of the tape shall provide an initial minimum skid resistance value of 45 BPN when tested according to ASTM E 303 except values shall be taken at downweb and at 45 degree angle from downweb. These two values will then be averaged to find the skid resistance of the patterned surface.
- D. **Thickness.** The patterned material without adhesive shall have a minimum caliper of 0.065 inches at the thickest portion of the patterned cross-section and minimum caliper of 0.02 inches at the thinnest portion of the cross-section.
- E. **Beads.** The glass beads on the surface of the material shall have a minimum index of refraction of 1.7 when tested using the liquid oil immersion method. The glass beads mixed into the pliant polymer shall have a minimum index of 1.5 when tested by the oil immersion method.
- F. **Patchability.** The pavement marking material shall be capable of use for patching worn areas of the same type according to the manufacturer’s instructions.
- G. **Reflectance.** The white and yellow markings shall have the following initial expected retroreflectance values as measured according to the testing procedures of ASTM D 4061. The photometric quantity to be measured shall be specific luminance (SL), and shall be expressed as millicandelas per square foot per foot candle. The test distance shall be 50 feet and the sample size shall be a 2.0 foot by 2.5 foot rectangle.

	White	Yellow
Entrance Angle	86.5°	86.5°
Observation Angle	1°	1°
SL	700*	500*

*All reflectance measurements shall be made using an “Ecolux” brand retroreflectometer or equivalent.

880.06 SHORT-TERM PAVEMENT MARKING.

Short-term pavement marking, placed on the top lift of asphalt paving projects and after final brooming on seal coat projects, shall meet Section 880.01. Pavement marking

paint for short-term pavement marking, on the lower lifts of asphalt paving projects and before final brooming on seal coat projects, may be commercially-available traffic marking paint, and shall be yellow or white in color.

Mixed commercially-available traffic marking paint shall show no signs of thickening, caking, livering, or curdling, and shall be free of water, skins, and any other foreign materials. At the time of application, the mixed paint shall be capable of being easily stirred with a paddle to a smooth, uniform consistency. The paint shall dry to an elastic, adherent finish that will not discolor in sunlight.

Glass beads for short-term pavement marking shall meet Section 880.02.

Pavement marking tape for short-term pavement marking shall be 4 inches wide with a pressure-sensitive adhesive backing and have reflectorizing glass beads embedded in the surface. The tape shall be durable and function effectively for the required period of service and adhere to the pavement surface.

880.07 CONSTRUCTION ZONE MARKING.

The wet retroreflective system shall consist of white or yellow retroreflective tape on a conformable backing with deformable highly retroreflective markers adhered transversely to the top surface with a pressure sensitive adhesive. The tape sheeting element, white or yellow, shall meet standard highway colors.

The size, quality, and refractive index of the glass beads shall be such that the performance requirements for the marking shall be met. The bead adhesion shall be such that beads are not easily removed when the material surface is scratched with a thumbnail.

The preformed tape shall be precoated with a pressure-sensitive adhesive and shall adhere to asphalt concrete or portland cement concrete, according to manufacturer's instructions, without the use of heat, solvents, or other additional adhesive means, and shall be immediately ready for traffic after application.

Preformed words and symbols shall meet the applicable shapes and sizes as shown on the Plans.

Preformed marking for construction zones shall be Type R - Removable Retroreflective Film, Type R-WR Removable Wet Retroreflective Film, or Type NR - Retroreflective Pavement Striping Tape (not easily removed) construction zone marking film. The Plans will specify which type to use. Requirements for each type are as follows:

A. Type R - Removable Retroreflective Pavement Markings.

The removable striping tape must be designed and constructed in such a manner that it can be readily removed when the markings are no longer applicable. The tape shall be capable of performing for the duration of a normal construction season and shall then be capable of being removed intact or in large pieces manually.

1. **Composition.** The removable preformed retroreflective pavement markings shall consist of glass beads embedded in white or yellow film with a thin flexible conformable backing which is precoated with a pressure sensitive adhesive. A structured interlaced medium shall be incorporated to facilitate removal.

2. **Reflectance.** The white and yellow films shall have the following initial minimum reflectance values at 0.2 degrees and 0.5 degrees observation angles and 86.0 degrees entrance angle as measured in accordance with the testing procedure of ASTM D 4061. The photometric quantity to be measured shall be specific luminance (SL), and shall be expressed as millicandelas per square foot per foot candle. The angular aperture of both the photoreceptor and light projector shall be 6 minutes of arc. The reference center shall be the geometric center of the sample, and the reference axis shall be taken perpendicular to the test sample.

	White			Yellow		
Entrance Angle	86.0°	86.0°	86.5°	86.0°	86.0°	86.5°
Observation Angle	0.2°	0.5°	1.0°	0.2°	0.5°	1.0°
Specific Luminance	1770	1270	750	1310	810	450

3. **Adhesion.** Short-Term Type R pavement markings shall be installed where air and pavement temperatures are 50°F and rising. The manufacture shall be required to demonstrate that the properly applied pavement marking adheres to the roadway under climatic and traffic conditions normally encountered in the construction work zone.
4. **Removability.** The marking film shall be removable from asphalt concrete and portland cement intact or in large pieces, either manually or with a roll-up device at temperatures above 40°F without the use of heat, solvents, grinding or blasting.
5. **Skid Resistance.** The surface of the markings provides an initial minimum skid resistance value of 50 BPN when tested according to ASTM E303-74.

B. Type NR - Retroreflective Pavement Striping Tape.

1. **Composition.** The pavement striping tape shall consist of a white or yellow retroreflective film on a conformable metallic backing, precoated with a pressure-sensitive adhesive.
2. **Reflectance.** The white and yellow films shall have the initial minimum values specified in the following table at 86 degree entrance angle when measured according to ASTM D 4061. The photometric quantity to be measured shall be specific luminance (SL) and shall be expressed as millicandelas per square foot per foot candle [(mcd/ft²)/fc]. The test distance shall be 50 feet, and the sample size shall be a 2.0-foot by 2.5-foot rectangle. The angular aperture of both the photoreceptor and light projector shall be 6 minutes of arc. The reference center shall be the geometric center of the sample, and the reference axis shall be taken perpendicular to the test sample.

	White		Yellow	
Observation Angle	0.2°	0.5°	0.2°	0.5°
SL [(mcd/ft ²)/fc]	1,360	760	820	510

3. **Skid Resistance.** The surface of the marking shall provide an initial minimum skid resistance value of 35 BPN when tested according to ASTM E 303.
4. **Abrasion Resistance.** Samples of the test material shall not wear through to the conformable backing surface in less than 125 cycles, when tested accord-

ing to Federal Test Method Standards 141, Method 6192, modified by using an H-22 wheel and a 250-gram load.

5. **Adhesion.** The manufacturer shall demonstrate that the properly-applied pavement marking adheres to the roadway pavement under climatic and traffic conditions normally encountered in construction work where proposed for use.

C. **Type R-WR Pavement Markings.** The removable striping tape must be designed and constructed in such a manner that it can be readily removed when the markings are no longer applicable. The tape shall be capable of performing for the duration of a normal construction season and shall then be capable of being removed intact or in large pieces manually.

1. **Materials.**

- a. **Composition.** The removable preformed retroreflective pavement markings shall consist of glass beads embedded in white or yellow film with a thin flexible conformable backing which is precoated with a pressure-sensitive adhesive. A structured interlaced medium shall be incorporated to facilitate removal.
- b. **Reflectance.** The white and yellow film shall have the following initial minimum reflectance values at an observation angle of 1.05 degrees and an entrance angle of 88.76 degrees under wet conditions, as measured in accordance with ASTM E 2176. The photometric quantity to be measured shall be specific luminance (SL), and shall be expressed as millicandelas per square foot per foot candle. The angular aperture of both the photoreceptor and light projector shall be six minutes of arc. The reference center shall be the geometric center of the same, and the reference axis shall be taken perpendicular to the test sample.

	White	Yellow
Entrance Angle	88.76°	88.76°
Observation Angle	1.05°	1.05°
Specific Luminance	250	200

- c. **Application/Adhesion.** Short-Term Type R-WR pavement markings shall be installed where air and pavement temperatures are 50°F and rising. The manufacturer shall be required to demonstrate that the properly applied pavement marking adheres to the roadway under elastic and traffic conditions normally encouraged in the construction work zone.
- d. **Removability.** The marking film shall be removable from asphalt concrete and portland cement intact or in large pieces, either manually or with a roll-up device at temperatures above 40°F without the use of heat, solvents, grinding, or blasting.
- e. **Skid Resistance.** The surface of the markings provides an initial minimum skid resistance value of 45 BPN when tested according to ASTM E 303-74.

880.08 RAISED PAVEMENT MARKERS.

Raised pavement markers shall consist of a plastic shell with one or more prismatic reflective faces with a minimum of 2.45 square centimeters of reflective surface for

each direction required to reflect incident light. The marker shall be fitted with pressure-sensitive adhesive for application to a primed surface.

The materials used shall be capable of being easily applied and removed. The Contractor shall demonstrate that the properly-applied pavement marking adheres to the roadway under climatic and traffic conditions normally encountered in the construction work zone.

880.09 EPOXY PAINT PAVEMENT MARKING.

A. **General.** This Specification provides for the classification of epoxy resin pavement marking systems by type. Type II shall be used unless Type I is specified on the plans.

1. Type I

A fast cure material suitable for line applications and, under ideal conditions, may not require coning.

2. Type II

A slow cure material suitable for all applications of pavement markings under controlled traffic conditions, i.e., coning is required and flagging may be as directed by the Engineer.

B. Epoxy Resin Material.

1. **General.** The material shall be composed of epoxy resins and pigments only. No solvents are to be given off to the environment upon application to a pavement surface. Type II material shall be completely free of TMPTA (Tri-Methyl Propane Tri-Acrylate) and other multi-functional monomers.
2. **Color.** The color of the white epoxy shall be a pure flat white, free of tints. The color of the yellow epoxy shall closely match Color Number 33538 of Federal Standard 595 and shall conform to the following CIE Chromaticity limits using illuminant "C":

$$\begin{array}{l} x \mid 0.470 \mid 0.485 \mid 0.520 \mid 0.480 \\ y \mid 0.440 \mid 0.460 \mid 0.450 \mid 0.420 \end{array}$$

Daylight Directional Reflectance (Y), white, minimum 83
Daylight Directional Reflectance (Y), yellow, minimum 50

Testing will be according to:

Daylight Directional Reflectance	ASTM D 2805
Color	ASTM D 2805

3. **Adhesion Capabilities.** When the adhesion of the material to portland cement concrete (the concrete shall have a minimum of 300 psi tensile strength) is tested according to American Concrete Institute Committee 503 testing procedure, the failure of the system must take place in the concrete. The laboratory concrete test specimen shall be 90°F when the material is applied, after which the material shall be allowed to cure for 72 hours at 73 ± 2°F.

- E. **Packaging of Epoxy Components and Glass Beads.** Containers for epoxy components shall be marked with the manufacturer's name, product identification number, lot or batch number, date of manufacture, color, net weight of contents. Containers for glass beads shall be marked with the name of manufacturer, the wording "Glass Beads," lot or batch number, coating type, date manufactured, and the net weight.

SECTION 894 HIGHWAY SIGNS AND POSTS

894.01 SIGN BACKING MATERIAL.

A. Materials.

1. **Flat Sheet Aluminum.** Flat sheet aluminum shall be an alloy meeting ASTM B 209 Alloy 6061 T6, or 5052-H38 with mill finish.
2. **Extruded Aluminum Panels.** Extruded Aluminum Panels shall meet ASTM B 221 Alloy 6063 T6. The panels shall be furnished in 12-inch and 6-inch sections as shown on the Plans. All panels shall be flat and straight within commercial tolerances established by the aluminum industry.

- B. **Shop Surface Preparation and Processing.** All sign backing shall be clean and free of rust, white rust, oil, and dirt. The holes shall be shop drilled to the sizes and at locations shown in the Contract. Holes required in the sign backing shall not be field drilled.

1. **Degreasing.** The extruded aluminum panels shall be rubbed with a clean white cloth after degreasing and if any sticky material shows up on the cloth, the panels shall be degreased again. All aluminum sign backing shall be degreased by one of the following methods:
 - a. **Vapor Degreasing.** Aluminum materials shall be immersed in a saturated vapor of Trichlorethylene. Trademark printing shall be removed with a lacquer thinner or a controlled alkaline cleaning system.
 - b. **Alkaline Degreasing.** The aluminum shall be immersed in an alkaline solution controlled and titrated according to the solution manufacturer's recommendations. The immersion time shall be dependent upon the gauge of the metal and the amount of soil to be removed.
2. **Etching.** All sheet aluminum shall be etched after degreasing. Extruded aluminum panels which have a roughened surface texture suitable for paint or sheeting shall not be etched after degreasing unless the Engineer determines the panels are unsuitable. Etching shall be performed by one of the following methods:

- a. **Acid Etch.** The aluminum shall be etched in a 6 percent to 8 percent solution of phosphoric acid at 100°F., or a proprietary acid etching solution. It shall be rinsed after etching with cold running water followed by a hot water rinse.
 - b. **Alkaline Etch.** The aluminum shall be etched in an alkaline solution controlled by titration. The length of time the aluminum is etched and the temperature and concentration of the solution shall comply with the solution manufacturer's instructions. The aluminum shall be well rinsed after etching. Smut on the aluminum shall be removed with an acidic chromium solution recommended by the solution manufacturer and then well rinsed.
3. **Coating.** Aluminum panels that have not had reflective sheeting applied for several days or longer, after being etched, shall be treated with a light, tightly adherent chromate conversion coating before applying the reflective sheeting. The chromate conversion coating shall be free of powdery residue and shall range in color from a silvery iridescence to a pale yellow. The coating shall meet ASTM B 449, Class 2, 10-35 milligrams/square foot with a median of 25 milligrams/square foot as an optimum coating weight.
 4. **Drying.** All sign backing material shall be dried with forced hot air after preparation and processing.

894.02 RETROREFLECTIVE SHEETING MATERIALS.

- A. **General.** The retroreflective sheeting stored under normal conditions shall be used within one year from the manufactured date. The packaging cartons or roll goods shall be marked with the manufacturer's lot numbers and manufacture date.

The surface of the barricade rails, drums, or cones shall be treated as recommended by the sheeting manufacturer before applying the reflective sheeting.

Type III C reflective sheeting shall have an identification symbol on the surface to differentiate it from other types of sheeting. The identification symbol shall not interfere with the function of the sheeting, but shall be visible to inspectors day or night without the use of special devices. The symbol shall be in a repeat pattern such that any 4-inch by 8-inch or 5-inch by 5-inch piece of the sheeting contains at least one full symbol.

The durability of the retroreflective sheeting shall be substantiated by the following accelerated weathering tests:

1. **Accelerated Outdoor Test.** When the retroreflective sheeting is processed and applied according to recommended procedures, the sheeting shall be weather-resistant, resistant to dirt and fungus accumulation, and following cleaning, shall show no discoloration, cracking, crazing, blistering, or dimensional change, and have not less than 50 percent for Type II and IV sheeting and not less than 80 percent for Type III A sheeting of the specified minimum brightness values shown in AASHTO M 268 measured at an observation angle of 0.2 degrees and an entrance angle of -4 degrees when exposed to accelerated weathering for 30 months, south-facing, unprotected at 45 degrees.

2. **Accelerated Machine Test.** The retroreflective sheeting shall meet the artificial weathering requirements of AASHTO M 268 measured at an observation angle of 0.2 degrees and an entrance angle of -4 degrees.

The Contractor shall furnish written evidence showing conformance with one of the following:

1. The accelerated outdoor test, done in North Dakota or in a state located at lower latitudes, or
2. The accelerated machine test and three years of performance in the field with no problems.

The Contractor shall secure from the manufacturer all warranties and guarantees with respect to materials, parts, workmanship, or performance which the products covered by the proposal bear, and include these warranties and guarantees with the certification.

- B. **Type II and III A Retroreflective Sheeting Material.** Type II and III A retroreflective sheeting shall meet AASHTO M 268 and the following:

Processed retroreflective sheeting shall be applied to approved sign base material and cleaned according to manufacturer's recommendations for use on traffic control signs. The Contractor shall furnish a written assurance that the sheeting will meet the requirements of the following tables throughout the satisfactory performance life and be effective for its intended purpose when viewed from a vehicle.

TYPE II RETROREFLECTIVE SHEETING

Sheeting Type and Color	Average Minimum Candelas per Foot Candle per sq. ft. at 0.2° divergence and -4° incidence*	Satisfactory Performance Life
Silver-White #1	30.0	5 years
Silver-White #2	36.0	5 years
Yellow	20.0	5 years
Red	5.0	5 years
Blue	2.0	5 years
Green	3.0	5 years
Orange	10.0	5 years
Brown	0.4	5 years

TYPE III A RETROREFLECTIVE SHEETING

Sheeting Type and Color	Average Minimum Candelas per Foot Candle per sq. ft. at 0.2° divergence and -4° incidence*	Satisfactory Performance Life
Silver-White	200.0	10 years
Green	36.0	10 years
Yellow	136.0	10 years
Red	36.0	10 years
Orange	80.0	3 years
Blue	16.0	10 years

*Candlepower measurement shall be made, following sign cleaning, in accordance with procedure recommended by the sheeting manufacturer.

- C. **Type III B Retroreflective Sheeting.** Type III B retroreflective sheeting shall consist of optical lens elements adhered to a synthetic resin and encapsulated by a flexible transparent plastic that has a smooth outer surface. The sheeting shall have a precoated adhesive protected by an easily removable liner. This sheeting is intended for use on rigid substrate signs and barricades used in the construction work zone. Type III B retroreflective sheeting shall meet AASHTO M 268 and the following:

The Contractor shall furnish a written assurance that the sheeting will meet the requirements of the following table throughout the satisfactory performance life and be effective for its intended purpose when viewed from a vehicle:

TYPE III B RETROREFLECTIVE SHEETING

Sheeting Type and Color	Average Minimum Candelas per Foot Candle per sq. ft. at 0.2° Divergence and -4° Incidence*	Satisfactory Performance Life
White	200	3 years
Yellow	136	3 years
Orange	80	3 years
Prestriped Barricade	200/80	3 years

*Candlepower measurement shall be made, following sign cleaning, in accordance with procedure recommended by the sheeting manufacturer.

The impact resistance shall be tested on reflective sheeting, applied according to the manufacturer's recommendations to a cleaned, etched aluminum panel of Alloy 6061 T 6, 0.063 inches by 3 inches by 5 inches and conditioned for 24 hours at 0°C.

The sheeting to be tested for flexibility shall be conditioned for 24 hours at 0°C.

- D. **Type III C Retroreflective Sheeting.** Type III C retroreflective sheeting shall consist of optical lens elements adhered to a synthetic resin and encapsulated by a

flexible transparent plastic that has a smooth outer surface. The sheeting shall have a precoated adhesive protected by an easily removable liner. This sheeting is intended for use on plastic reboundable devices such as drums and flexible delineation posts. Type III C retroreflective sheeting shall meet the weathering requirements of AASHTO M 268, Type IV and the following:

The Contractor shall furnish a written assurance that the sheeting will meet the requirement of the following table and be effective for its intended purpose when viewed from a vehicle.

TYPE III C RETROREFLECTIVE SHEETING

Average minimum Candelas per foot candle per square foot.

Observation Angle	Entrance Angle	White	Yellow	Orange
0.2°	-4°	250	170	100
0.2°	+30°	150	100	60
0.5°	-4°	95	62	30
0.5°	+30°	65	45	25

The impact-resistant aluminum panel shall be the same as Type III B reflective sheeting.

The impact resistance shall be tested on a Gardner Variable Impact Tester, I6-1120 using a four-pound weight with a 5/8-inch rounded tip dropped from a 100 inch-pound setting.

Type III C reflective sheeting performance on reboundable plastic substrates shall be measured using the following test:

The device shall be impacted three times by a 4,000-pound vehicle, with a 20-inch bumper, at 40 mph. Each impact shall be a direct hit (glancing blows will not be allowed). After the impacts, the reflective sheeting shall be considered performing satisfactorily when no loss of sheeting results and there is no visible change in day and night performance (when viewed from 500 feet).

The sheeting to be tested for flexibility shall be conditioned for 24 hours at 0°C.

E. **Type IV Reflective Sheeting.** The Type IV reflective sheeting shall consist of high-gloss transparent ultraviolet light-stabilized polyester film bonded to a layer of polyester cube corner prisms with not less than 40,000 prisms per square inch meeting AASHTO M 268 and the following:

1. **Type IV, Class 1 Reflective Sheeting.** The backing for the polyester sheeting used on barricade rails, drums, and traffic cones shall be an opaque-white plasticized polyester film not less than 0.004 inch thick with an adhesive backing meeting AASHTO M 268, Class 1.
2. **Flexible Rollup Sign, Non-Adhesive Backing Fabric.** The polyester sheeting on the flexible rollup portable signs shall be coated on both sides with orange pigment polyester and shall meet the following Specifications:

Base Fabric

Fiber	1,000 denier polyester
Weight	3 ounces/square yard
Fabric Count	10 warp, 10 fill

Coated Fabric

Total Weight	14 ± 1/2 ounces/square yard
Type of Coating	PVC
Color	Orange
Distribution	60 face, 40 back

Mechanical Properties**Federal Standard
191 Method**

Tensile Strength	Warp 250, Fill 200	5100
Tear Strength	Warp 85, Fill 95	5134.1
Low Temperature	-65°F.	
High Temperature		
Continuous	+180°F.	
Abrasion Resistance (Taber)	1,700 Cycles	5306
Flame Resistance	California Fire Marshall Approved Reg. No. F 102.4	

- F. **Wide Angle Prismatic Reflective Sheeting.** The sheeting shall consist of prismatic lenses formed in a transparent synthetic resin, sealed, and backed with an aggressive pressure sensitive adhesive protected by a removable liner. The sheeting shall have a smooth surface with a distinctive interlocking diamond seal pattern and orientation marks visible on the face.

MINIMUM COEFFICIENT OF RETROREFLECTION
(Candelas per foot candle per square foot)
90° Rotation Angle

Observation Angle (Deg.)	Entrance Angle (Deg.)	White	Orange
0.2	-4	800	300
0.2	+30	400	150
0.2	+50	120	50
0.5	-4	200	100
0.5	+30	100	50
0.5	+50	40	20

Daytime color shall conform to the table shown below. Color of sheeting mounted on aluminum test panels shall be determined instrumentally in accordance with ASTM E 1164. Values shall be determined on a HunterLab Labscan 6000-0/45 Spectrocolorimeter with option CMR 559. Computations shall be done in accordance with ASTM E 308 for the 2 degree observer.

COLOR SPECIFICATION LIMITS* (DAYTIME)

Color	1		2		3		4		Reflectance Limit Y (%)	
	x	y	x	y	x	y	x	y	min.	max.
White	0.303	0.300	0.368	0.366	0.340	0.393	0.274	0.329	40	-
Orange	0.558	0.352	0.636	0.364	0.570	0.429	0.506	0.404	12	30

*The four pairs of chromaticity coordinates determine the acceptable color in terms of the CIE 1931 standard colorimetric system measured with standard illuminant D65.

The sheeting shall show no cracking outside the impact area when the face of the panel is subjected to an impact of 100 inch-pounds, using a weight with a 5/8 inch diameter rounded tip dropped from a height necessary to generate an impact of 100 inch-pounds, at temperatures of both 32°F. and 72°F.

The impact-resistant aluminum panel shall be the same as required for Type III B reflective sheeting.

The Retroreflective Sheeting shall be processed and applied to aluminum sign blank materials in accordance with the sheeting manufacturer's instructions. The sheeting shall perform effectively for three years. If, within three years from the date of acceptance, the sheeting has deteriorated due to natural causes to the extent that (1) the sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day or night driving conditions by a driver with normal vision; or (2) the coefficient of retroreflection, after cleaning, is less than 400 for white and 150 for orange when measured at 0.2 degrees observation and -4 degrees entrance at 90 degrees rotation; new sheeting will be furnished and installed by the Contractor.

- G. **Fluorescent Orange Wide Angle Prismatic Retroreflective Sheeting.** The sheeting shall consist of prismatic lenses formed in a transparent fluorescent orange synthetic resin, sealed, and backed with an aggressive pressure sensitive adhesive protected by a removable liner. The sheeting shall have a smooth surface with distinctive interlocking diamond seal pattern and orientation marks visible from the face.

MINIMUM COEFFICIENT OF RETROREFLECTION
(Candelas per foot candle per square foot)
90° Rotation Angle

Observation Angle (Deg.)	Entrance Angle (Deg.)	Orange
0.2	-4	200
0.2	+30	120
0.2	+50	50
0.5	-4	80
0.5	+30	50
0.5	+50	20

Daytime color and maximum spectral radiance factor (peak reflectance) shall be determined in accordance with ASTM E 991 using a HunterLab Labscan 6000-0/45.

COLOR SPECIFICATION LIMITS (DAYTIME)

Color	1		2		3		4		Reflectance Limit Y (%)	
	x	y	x	y	x	y	x	y	min.	max.
Orange (new)	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355	30	-
Orange (weathered)	0.583	0.416	0.523	.396	0.560	0.360	0.631	0.369	20	45

Nighttime color shall be determined in accordance with ASTM E 811 and calculated in accordance with ASTM E 308. Sheeting shall be measured at 0.33 degrees observation and -4 degrees entrance at 90 degrees rotation.

COLOR SPECIFICATION LIMITS (NIGHTTIME)

Color	1		2		3		4	
	x	y	x	y	x	y	x	y
Orange (new and weathered)	0.625	0.375	0.589	0.376	0.636	0.330	0.669	0.331

The sheeting impact resistance requirements shall be the same as in Section 894.02 F.

The impact-resistant aluminum panel shall be the same as that required in Section 894.02 F.

The field performance requirements shall be the same as specified in Section 894.02 F., except that coefficient of refraction for the fluorescent sheeting can be no lower than 100.

894.03 PIGMENTED PLASTIC FILM, PRESSURE-SENSITIVE ADHESIVE.

- A. **Description.** This material shall be flexible, pigmented plastic film completely precoated with a pressure-sensitive adhesive. The adhesive shall be protected by a treated paper liner which shall be removable without soaking in water or other solvents. The material shall be available in colors listed in Section 894.03 B.7.
- B. **Material Requirements.** Material requirements shall be as follows:
1. **Thickness.** The thickness of the plastic film with adhesives shall be a minimum of 0.003 inch and a maximum of 0.0045 inch.

2. **Film.** The unapplied and applied film shall be readily processed and shall ensure adequate adhesion with process or printed inks recommended by the manufacturer.
3. **Flexibility.** The material shall be sufficiently flexible to permit application over and conformance to moderately-contoured surfaces.
4. **Gloss.** The film shall have a minimum initial 60 degree gloss value of 35 when tested according to ASTM D 523, measuring at least three portions of the film to obtain uniformity.
5. **Adhesive.** The precoated adhesive shall form a durable bond to smooth, clean, corrosion-resistant, and weather-resistant surface; shall be of uniform thickness; shall be noncorrosive to applied surfaces; and shall have no staining effect on the film. The adhesive shall adhere securely at temperatures of -30°F. to +200°F.; shall not crack, chip, or peel voluntarily; nor shall it be removed from the panel in one piece without the aid of a tool.
6. **Sunlight Resistance.** There shall be no effect on the adhesive tack or performance following exposure of the adhesive face under a new General Electric RS Sunlamp for a period of six hours at a distance of 8 inches.
7. **Exterior Exposure.** The unprocessed material shall withstand the years of exposure, listed below by color, in a vertical, south facing exterior exposure in Texas. During the exposure, the unprocessed material shall show no appreciable discoloration, cracking, crazing, blistering, delamination, or loss of adhesion. A slight amount of chalking is permissible. The Contractor shall furnish a written assurance from the manufacturer that the sheeting will meet the requirements of the following table and be effective for its intended purpose when viewed from a vehicle, throughout the satisfactory performance life:

Color	Satisfactory Performance Life
White	7 years
Black	7 years
Yellow	5 years
Aluminum	5 years
Insignia Blue	5 years
Transparent	5 years
Red	3 years
Gold	3 years

The Contractor shall secure from the manufacturer all warranties and guarantees with respect to materials, parts, workmanship, or performance which the products covered by the proposal bear, and include these warranties and guarantees with the certification.

8. **Fungus Growth.** The film shall not support fungus growth.
9. **Plastic Lettering.** Plastic lettering film as furnished in rolls, sheets, or letters shall be free from ragged edges, cracks, blisters, streaks, foreign matter, or

other surface imperfections which would make it unsuitable for usage. The plastic lettering film shall be capable of being readily cut with scissors, knives, blades, or shears without cracking, crazing, checking, or flaking.

894.04 LETTERS, NUMERALS, SYMBOLS, AND BORDERS FOR PANEL SIGNS.

- A. **General.** All letters, numerals, symbols, and borders shall meet the requirements shown in the Contract and the MUTCD.

All letters, numerals, symbols, and borders shall have a regular outline and be clean-cut and sharp. All letters, numerals, and symbols shall have a continuous stroke and border. In special cases, symbols may have a broken stroke and border, provided they do not exceed more than two increments and that they are necessary for manufacturer's fabrication.

Blind rivets used for mounting shall conform to the Plans and shall extend past the back of the sign backing for a minimum distance of 1/8 inch. They shall be made of nonrust material.

- B. **Demountable Reflectorized Cutout Letters, Numerals, Symbols, and Borders.** Demountable reflectorized cutout type letters, numerals, symbols, and borders shall consist of adhesive-coated reflective sheeting permanently adhered to a flat sheet aluminum backing. Type III and IV reflective sheeting meeting Section 894.02 shall be used.

The reflective sheeting shall be applied to the properly-prepared aluminum with the equipment and in the manner prescribed by the sheeting manufacturer.

Letters, numerals, symbols, and border backing shall be aluminum alloy meeting ASTM B 209, Alloy 6061 T6 or 5052 H38 with mill finish and of the thickness shown on the Plans. Aluminum backing shall be properly degreased and etched as specified in Section 894.01 B.

Mounting holes shall be uniformly spaced around the letters or characters and shall have the edge clearance shown in the Contract. The spacing shall be determined by the character size and shape. Mounting holes shall be spaced no more than 8 inches on centers, except for characters of 8 inches in height or less. For characters 8 inches high or less, the maximum spacing of mounting holes shall be 4 inches. Mounting holes shall be drilled by the manufacturer.

Each letter, numeral, symbol, and border shall be offset, unless otherwise specified, as shown on the Plans with aluminum shim spacers meeting ASTM B 221, Alloy 2024. Finish of the letters, numerals, symbols, and borders shall be done with material and in the manner specified by the manufacturer of the reflective sheeting.

- C. **Direct Applied Type III A and III B Reflective Sheeting Letters, Numerals, Symbols, and Borders.**
1. **General.** The letters, numerals, symbols, and border shall consist of adhesive-coated, pressure-sensitive reflective sheeting meeting Section 894.02. The material used for fabrication of letters, numerals, symbols, borders, and

route markers shall be sampled and tested as specified for other reflective materials.

2. **Fabrication.** Letters, numerals, symbols, and borders shall be cut from reflective sheeting and shall have smooth regular outline, free from ragged or torn edges. Letters, numerals, and symbols having interior or exterior corners shall have these corners cut with a smooth $3/16$ inch \pm $1/16$ inch radius. Border corners and strips shall have no corner radius. Route markers used in conjunction with direct-applied letter shall be applied to 0.040 aluminum backing and shall be attached with blind rivets or other common nonrust fasteners. Fasteners shall be placed a maximum of 6 inches on center around the perimeter of the shield. The reflective sheeting shall be of the same type specified for the letters. All sheeting, numerals, symbols, and borders shall show careful workmanship and shall be of regular outline.

894.05 POSTS AND HARDWARE FOR SIGNS.

A. Hardware for Signs.

1. **General.** All aluminum bolts, nuts, U-bolts, lockwashers, and washers shall be given at least a 0.002-inch anodic coating and chromate seal. All steel bolts, nuts, U-bolts, lockwashers, and washers shall be galvanized steel meeting ASTM A 153.

Use of substitute alloys in lieu of the alloy specified for various items of "Hardware for Signs" may be approved by the Engineer upon submission of documented evidence that the proposed substitute alloy has applicable qualities equal to or superior to the designated alloy.

2. **Bolts.** Aluminum panel bolts, etc., shall be fabricated of aluminum alloy meeting ASTM B 211, Alloy 2024 T4 or 6061 T6.

Steel panel bolts, machine bolts, etc., shall meet ASTM A 307.

3. **Nuts.** Aluminum nuts, hex nuts, vandal-resistant nuts shall be fabricated of aluminum alloy meeting ASTM B 211, Alloy 6061 T6.

Steel hex nuts shall meet ASTM A 307.

In lieu of using torque wrenches to obtain the required torques for fuse joints and slip base used in the breakaway system, the Torque Control Nut System may be used. This system shall provide automatic torque control, consistently-controlled preload, vibration resistance, high strength, easy installation, simple inspection, and resistance to weather effects.

The torque control nut shall be designed to mate with standard high-strength bolts meeting ASTM A 325. The minimum stripping strength of the threads shall be equal to or shall exceed the strength level of the mating bolts.

The self-locking quality of resistance to loosening shall meet the tests in Federal Specification MIL N 25027 and shall be installed according to the manufacturer's recommendations.

4. **Washers.** Aluminum lockwashers shall be fabricated of aluminum alloy meeting ASTM B 209, Alloy 7075 T6.

Aluminum flat washers shall be fabricated of aluminum alloy meeting ASTM B 209, Alloy 2024 T4.

Steel lockwashers shall be fabricated of steel meeting ANSI B 27.1.

Steel flat washers shall be fabricated of steel meeting ASTM A 307.

Plastic washers shall be fabricated to the sheeting manufacturer's specifications.

5. **Stringers.** Aluminum stringers shall be fabricated to Plan dimensions and made of aluminum alloy meeting ASTM B 221, Alloy 6061 T6 or ASTM B 308, Alloy 6061 T6.

Steel stringers shall be fabricated to Plan dimensions and made of steel meeting ASTM A 36.

6. **Aluminum Alloy Castings.** Brackets, post caps, and fuse plates may be either permanent mold castings or sand castings.

Aluminum alloy permanent mold castings shall meet ASTM B 108, Alloy SG70A F or SG80A T6.

Aluminum alloy sand castings shall meet ASTM B 26, Alloy SG70A F or SG70A T6.

7. **Steel Castings.** Brackets, post caps, and fuse plates shall meet AASHTO M 103, Grade 65-35.

8. **U-Bolts.** Aluminum U-bolts shall be fabricated of aluminum alloy meeting ASTM B 211, Alloy 2017 T4.

Steel U-bolts shall be fabricated of steel meeting ASTM A 307.

9. **Anchor Bolts.** Anchor bolts, anchor studs, nuts, and washers shall be fabricated of steel meeting ASTM A 307 and meet AASHTO M 314 Grade 55 Mechanical requirements.

All nuts, washers, and anchor studs shall be galvanized steel meeting ASTM A 153.

The hex bar shall be tapped with U.S.S. Standard right thread, both ends, and made of steel meeting ASTM A 307.

10. **Attachment Clip and Plate.** Attachment clip and plate for attachment of steel panels shall be fabricated as shown in the Contract, and made of steel meeting ASTM A 283 and galvanized in conformance to ASTM A 153.

11. **Fuse Joint Bolts.** Aluminum fuse plate bolts and washers shall be fabricated from aluminum meeting ASTM B 211, Alloy 2024 T4.

Steel fuse plate bolts and washers shall be fabricated from steel meeting ASTM A 325, and nuts shall be of the capacity to develop the bolt strength. Bolts, nuts, and washers shall be galvanized according to ASTM A 153.

12. **Breakaway Base Bolts.** All breakaway base bolts shall have bolts and washers fabricated from steel meeting ASTM A 325, and nuts shall be of the capacity to develop the bolt strength. Bolts, nuts, and washers shall be galvanized according to ASTM A 153.

B. Posts.

1. **General.** Tubular post size, length, and weight shall be as shown in the Contract for each type of sign.

Welding on aluminum shall be done according to Section 6 and welding on galvanized steel shall be done according to Section 5 of the *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*.

All markings on posts, signs, casting, etc., shall be removed after erection.

2. **Aluminum Tubular Posts and Accessories.**

Material	Specification
Drawn Seamless Tubes and Extruded Round or Square Tubes	ASTM B 210, Alloy 6061 T6 or ASTM B 241, Alloy 6061 T6
Extruded Structural Shapes	ASTM B 221, Alloy 6061 T6
Breakaway Bases	ASTM B 209, Alloy 6061 T6
Fuse Plates	ASTM B 209, Alloy 6061 T6
Fuse Plate Bolts and Washers	ASTM B 211, Alloy 2024 T4

3. **Steel (Galvanized) Posts and Accessories.**

Material	Specification
Standard Steel Pipe	AASHTO M 111, 270 Grade 36, and M 232
Breakaway Bases	AASHTO 270 Grade 36 and M 232
Fuse Plates	AASHTO 270 Grade 36 and M 232

4. **Square Steel Telescoping Tubular Posts.** Tubing shall be of the size and shape shown in the Contract and shall meet the following requirements:
 - a. **Material.** Steel posts shall conform to the standard specifications for a Grade 55 hot rolled carbon sheet steel, structural quality, ASTM designation A 570.

- b. **Shape.** The cross section of the post shall be square tube formed of 12 gauge (0.105 U.S.S. gauge) and 10 gauge (0.135 U.S.S. gauge) steel, carefully rolled to size and shall be welded directly in the corner by high frequency resistance welding and externally scarfed to agree with corner radii.
- c. **Finish.** Signposts shall be manufactured from hot-dipped galvanized steel conforming to ASTM specification A 653, designation G90. The corner weld shall be zinc coated after scarfing operation. The steel shall be coated with a chromate conversion coating and a clear organic polymer topcoat. Both the interior and the exterior of the post shall be galvanized.
- d. **Cross Section.** Perforated sign posts shall be one or more of the following sizes:

Size	U.S.S. Gauge	Weight (lbs./foot)
1 1/2" × 1 1/2"	12	1.70
2" × 2"	12	2.42
2 1/4" × 2 1/4"	12	2.77
2 1/2" × 2 1/2"	12	3.14
2 3/16" × 2 3/16"	10	3.43
2 1/2" × 2 1/2"	10	4.01

- e. **Holes.** Holes shall be $7/16 \pm 1/64$ inches in diameter on one (1) inch centers on all four sides down the entire length of the post. The holes shall be on centerline of each side in true alignment and opposite each other directly and diagonally. All metal shall be removed from the punched holes.
- f. **Length.** The length of each post shall have a permissible length tolerance of $\pm 1/4$ inch.
- g. **Telescoping Properties.** The finished posts shall be straight and have a smooth, uniform finish. It shall be possible to telescope all consecutive sizes of square tubes freely and for not less than ten feet of their length without the necessity of matching any particular face to any other face. All holes and ends shall be free from burrs and ends shall be cut square.
- h. **Tolerances.**

(1) Tolerances on outside sizes:

Nominal Outside Dimensions	Outside Tolerances at All Sides at Corners
1 1/2" × 1 1/2"	$\pm .006$ "
2" × 2"	$\pm .008$ "
2 1/4" × 2 1/4"	$\pm .010$ "
2 1/2" × 2 1/2"	$\pm .010$ "
2 3/16" × 2 3/16"	$\pm .010$ "

Note: Measurements from outside dimensions shall be made at least 2 inches from the end of the tube.

- (2) **Wall Thickness Tolerances.** Permissible variation in wall thickness is $+.011$ inch - $.008$ inch.
- (3) **Convexity and Concavity.** Measured in the center of the flat sides, tolerance in $\pm.010$ inch, determined at the corner.
- (4) **Squareness of Sides and Twist.**

Nominal Outside Dimensions	Squareness Tolerance	Twist Permissible in 3 Feet Length
1 1/2" x 1 1/2"	$\pm.009$ "	.050"
2" x 2"	$\pm.012$ "	.062"
2 1/4" x 2 1/4"	$\pm.014$ "	.062"
2 1/2" x 2 1/2"	$\pm.015$ "	.075"
2 3/16" x 2 3/16"	$\pm.014$ "	.062"

Note: A sample shall be considered to fail if its sides are not 90 degrees to each other within the squareness tolerance listed above.

- (5) **Straight Tolerance.** Permissible variation in straightness is 1/16 of an inch in 3 feet.
- (6) **Corner Radii.** Standard outside corner radius shall be 5/32 of an inch $\pm 1/64$ inch.
- i. **Installation.** The square end of the post shall not be modified or pointed, but shall be capable of being driven into the ground with the use of an approved driving cap.
- j. **Slip Base Assembly.** The design and the construction of the slip base assembly shall be as shown on the Plans. The assembly shall be as manufactured by Unistrut Corporation or approved equal. The manufacturer shall certify that the chemistry, geometry, and mechanical properties are the same as those used in the tests and that the assembly will meet FHWA change-in-velocity requirements.

5. Accessories.

- a. **Anchor Plates.** The anchor plates shall be rolled from High Strength, Hot-Rolled Steel conforming to ASTM A 499, Grade 60, 60,000 psi minimum yield strength and 90,000 psi minimum ultimate strength.
- b. **Safety Retainer-Spacer Strap.** The straps shall be of the size and shape specified and shall be fabricated from steel meeting AISI 1020.
- c. **Nuts and Bolts.** The bolts shall be the size specified and shall be fabricated from steel meeting ASTM A 354, Grade BD, case hardened. The nuts shall meet AASHTO M 291, Grade DH, and lockwashers shall be heavy-duty external type. Nuts and bolts shall be cadmium plated ASTM A 165, Type 05, except when using clear chromate.
- d. **Fabrication.** The finished post shall be machine straightened and have a uniform finish, free from defects affecting its strength, durability, or ap-

pearance. All holes and sheared ends shall be commercially free from burrs.

Sign posts and stringers shall be punched on the center line with 7/16-inch diameter holes on one-inch centers for the entire length.

Base posts shall be punched on center line with a minimum of 12 7/16-inch diameter holes on one inch centers. The first hole shall be one inch from the top. The bottom of the post shall be pointed for easy installation.

The sign post, base posts, retainer-spacer, and anchor plates shall be galvanized according to AASHTO M 232.

6. **Structural Steel Posts.** Structural steel posts shall be fabricated from material conforming to Section 834.01 A. and shall be galvanized according to Section 854 after fabrication.

894.06 DELINEATORS.

- A. **Posts.** Steel posts shall meet ASTM A 702.

Steel posts shall be galvanized according to AASHTO M 111 or be aluminum posts fabricated from aluminum alloy meeting ASTM B 308, Alloy 6061-T6.

Posts shall have holes at 1 inch spacing the entire length of the post.

- B. **Reflectors.**

1. **Reflective Sheeting.** Type III reflective sheeting for delineators shall be white or yellow adhesive coated, permanently adhered to aluminum or galvanized steel.

The reflective sheeting shall meet Section 894.02. Backing material shall meet Section 894.01.

The finished reflector shall show careful workmanship; be free of burrs, scratches, or damaged reflective sheeting; and have essentially a flat surface.

2. **Acrylic Plastic.**

- a. **Metal Parts.** The housing shall be .020-inch ASTM B 209 3003 H14, or 5052 0 sheet aluminum formed to approximately 3-1/4 inches in diameter and 0.235-inch in depth to retain the acrylic reflector. The housing shall be provided with four embossed circular reinforcement ribs and marked with the manufacturer's name and part number.

An aluminum grommet with a 3/16-inch inside diameter shall be expanded within the reflector mounting hole.

- b. **Acrylic Plastic.** The reflector shall be an acrylic plastic manufactured from methyl methacrylate. The reflector shall consist of a clear and transparent plastic face, with a minimum of 7 square inches of reflective

area, referred to as the lens. It shall have a heat sealable plastic coated metallic foil back fused to the lens under heat and pressure around the entire perimeter of the lens and the central mounting hole to form a unit permanently sealed against dust, water, and water vapor. The reflector shall be colorless, yellow, or red.

The lens shall consist of a smooth front surface free from projection or indentation other than the central mounting hole and identification with a rear surface bearing a prismatic configuration such that it will provide total internal reflection of light.

- c. **Optical Requirements.** The optical requirements shall be as follows:

Observation Angle (degrees)	Entrance Angle (degrees)	Coefficient of Luminous Intensity (cd/lx)		
		Crystal	Yellow	Red
0.1	0	11.0	6.6	2.7
0.1	20	4.4	2.6	1.0

The reflex reflector to be tested shall be located 100 feet from a single light source having an effective diameter of 2 inches; the light source shall be operated at approximately normal efficiency. The return light from the reflector shall be measured by a photoelectric photometer having a minimum sensitivity of 1×10^{-7} foot candles per mm scale division. The photometer shall have a receiver aperture of 0.5 inch diameter, shielded to eliminate stray light. The distance from light source center to aperture center shall be 2.1 inches for 0.1 degree observation angle. During testing, the reflector shall be spun to average the orientation effect. If a test distance other than 100 feet is used, the source and aperture dimensions and the distance between source and aperture shall be modified in the same proportion as the test distance.

Failure to meet the specific intensity minimum shall constitute failure of the reflector being tested; failure of more than two reflectors out of 50 subjected to test shall constitute failure of the lot.

- d. **Durability.** The durability tests shall be as follows:

- (1) **Seal Test.** The following test shall be used to determine if a reflector is adequately sealed against dust and water.

Submerge 50 samples in a water bath at room temperature. Subject the submerged samples to a vacuum of 5 inches for 5 minutes, then examine them for water intake. Failure of more than 2 percent of the number tested shall be cause for rejection.

- (2) **Heat Resistance Test.** Three reflectors shall be tested for 4 hours in a circulating air oven at $175^{\circ} \pm 5^{\circ}\text{F}$. The test specimens shall be placed in a horizontal position on a grid or perforated shelf permitting free air circulation. At the conclusion of the test, the samples shall be removed from the oven and permitted to cool in air to room temperature. The samples, after exposure to heat, shall show no significant change in shape and general appearance when compared with unexposed control standards. No failures will be permitted.

- C. **Fasteners.** Aluminum tension pin fasteners shall be an aluminum alloy meeting ASTM B 211, Alloy 2024 T4 or 6061 T6. The collar shall be aluminum alloy meeting ASTM B 211, Alloy 6061-T67 or 6061 T6. The fasteners shall conform to the Contract.

Steel tension pin fasteners shall be a medium carbon steel with a minimum shear strength of 70,000 psi and a minimum tensile strength of 67,500 psi. They shall be galvanized according to AASHTO M 232 conforming to the Contract.

894.07 SAMPLING AND TESTING.

- A. **Base Metal.** The Contractor shall furnish to the inspector a certification as specified in Section 801.01.
- B. **Solutions for Cleaning and Etching.** The solutions used for cleaning and etching shall not vary more than 10 percent from the manufacturer's recommendation. In addition, all treatment tanks shall be charged with fresh chemicals at least once a year. Titration equipment shall be available for the inspector's use to check the solution strengths.
- C. **Inspection.** All material and finished signs are subject to inspection at the place of manufacture and shall be subject to final inspection at the time of erection. Test panels, 12 inches by 12 inches representative of any stage of production, shall be furnished upon the inspector's request. These panels shall be processed with the regular production run and witnessed by the inspector. All surfaces exposed to weathering shall be free of any defects that may impair the serviceability or detract from the general appearance or color matching of the sign. Signs with any defects or damage that would affect their appearance or serviceability will not be accepted. No repairs shall be made to the face sheet without the approval of the inspector. Signs not conforming in all respects to the requirements will be rejected.
- D. **Reflective Sheeting.** The reflective sheeting shall be certified by the manufacturer that the minimum brightness values previously listed for each color, have been met. The color of each type shall be checked by the inspector using the standard color charts as specified.
1. **Reflective Sheeting Flexibility.** The Contractor shall furnish test specimens for each color of reflective sheeting according to AASHTO M 268. Type III and Type IV reflective sheeting shall be applied to a plate as specified in AASHTO M 268 and shall be furnished for each color. These test specimens shall be processed with the regular production run and witnessed by the inspector.
 2. **Inspection.** The reflective sheeting packages shall be inspected before installation on sign backings. The Contractor shall provide access by the inspector and shall indicate the roll packages or flat packages to be used on a particular Project. The inspector will mark the roll of flat material and note the manufacturer's date. All material used on that Project shall be used within one year of this date. If this date is past on the date of inspection, the roll shall be rejected.
- E. **Torque Control Nuts.** The Contractor shall furnish to the inspector a certification, as specified in Section 801.01, if torque control nuts are chosen for use.

894.08 STRUCTURES FOR OVERHEAD SIGNS.

A. **General.** Shop drawings shall be submitted for all structures for overhead signs. Submission shall be according to Section 770.02 B, Volume 2. Welders as specified in 105.06 D.

1. **Welding.**

a. **Welding Steel.** All steel welding shall be done according to the specifications for welding of steel structures in the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

- (1) **Treatment of Welded Areas.** The individual components may be galvanized after fabrication according to AASHTO M 111, or each member may be galvanized before fabrication as specified in Sections 894.08 B and C. Areas damaged by welding may be metallized by one of the methods in Sections 894.08 A.1.a.(2) or (3).

When galvanizing after fabrication, the struts and diagonal tubes shall have a 3/4-inch minimum hole punched into chords to facilitate galvanizing. The chords on the capped end shall have two 1/2-inch holes at top and bottom to facilitate galvanizing. The end tower vertical columns shall have two 1/4-inch holes in the base plate and two 3/4-inch holes at the top of each column to facilitate galvanizing.

- (2) **Metallizing Process.** The portion of the unit on which the galvanized coating has been damaged shall be thoroughly cleaned by blasting with sharp sand or steel grit. The blasted area shall extend at least 1/2-inch over the undamaged section of galvanized coating. The area shall be coated with zinc within 24 hours after blasting. Should there be a delay of more than 24 hours, or should any of the cleaned portion become soiled before metallizing, these sections shall be reblasted.

Zinc wire containing at least 99.98 percent zinc shall be used in the metallizing operation. The pure zinc coating applied to the section shall have a thickness of at least 0.005 inch (2.98 oz. per square foot) over the damaged section, and shall taper off to zero thickness at the edge of the blasted undamaged section.

Areas which have not been cleaned or coated satisfactorily shall be rejected. If the Engineer so elects, the metallizing shall be done in the Engineer's presence.

- (3) **Paint-on-Galvanizing.** Paint-on-galvanizing shall be applied to areas that have been damaged, in the manner specified by Federal Specification MIL P 21035.

b. **Welding Aluminum.** All aluminum welding shall be done according to the specifications for welding aluminum structures, in AASHTO Stan-

Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

Welding shall be carefully checked by the fabricator by visual inspection of all welds, by proof testing of welds, and by restrictive testing of weld samples fabricated during the production welding.

2. **Grating and Handrail.** The walkway grating and handrail shall be of the type and material shown in the Contract. If grates require splicing, the splice shall be at the center of the support. The rail may be in one or more pieces, depending on length, with a post assembly at each end of each piece of rail.

The aluminum grating shall meet ASTM B 221, Alloy 6061 T6. The aluminum grating shall resist a point load of 500 pounds and shall have a deflection of 1/4-inch or less when loaded with a uniform load of 100 pounds per linear foot. The deflection shall be based on a simple span, 5 feet in length.

The U-bolts, bolts, washers, nuts, and clips shall be austenitic stainless steel.

The aluminum railing shall be composed of 1-1/4-inch nominal diameter Schedule 40 pipe and fittings, with flush surfaces. Joints between the pipe and fittings shall be welded and ground smooth. Railings shall be made in sections of suitable size to be raised or lowered by one man from one end of each section. The railing hinge and locking pin shall be of the type specified.

B. Free Standing Overhead Signs.

1. **Round Tubes and Standard Pipe.** Steel round tubes and standard pipe members shall meet AASHTO 270 Grade 36, M 161, or ASTM A 53 (Grade B Steel) and shall be galvanized according to AASHTO M 111.
2. **Round-Tapered or Octagonal-Tapered Tubes.** The overhead sign structure may be designed and fabricated from round-tapered or octagonal-tapered steel tubes in lieu of round and standard pipe as shown in the Contract. Major dimensions shall be retained, such as truss cross section and length, and end towers vertical dimensions. If this option is chosen, the Contractor shall furnish to the Department all necessary calculations and drawings used in designing these structures. The structures shall be designed according to the latest issue of the AASHTO publication of Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals. A wind velocity of 85 mph shall be used to compute the wind pressures on the signs and structures. Shop drawings shall be submitted after the above design has been submitted and approved.

The round-tapered or octagonal-tapered tube members shall have a minimum yield strength of 50,000 psi after fabrication. The shaft shall have no more than one longitudinal weld and shall be galvanized according to AASHTO M 111.

3. **Flat Bars.** Flat bar members shall meet AASHTO 270 Grade 36, or M 161 and galvanized according to AASHTO M 111.
4. **Flange.** Flange, base plate, clamps, and plate material shall be the same material used in fabricating columns and truss chords.

5. **Truss.** Steel shapes shall meet AASHTO 270 Grade 36, or M 161 galvanized according to AASHTO M 111.
6. **Hardware.** Steel bolts shall be fabricated according to ASTM A 325, and galvanized according to AASHTO M 232. Steel U-bolts shall be fabricated from round steel bars and threaded on both ends meeting ASTM A 307, and galvanized according to AASHTO M 232.
7. **Anchor Bolts, Nuts, and Washers.** The material used for anchor bolts shall be medium carbon, hot rolled steel bars meeting AASHTO M 314 Grade 55 and the following mechanical requirements:

Yield Strength	55,000 psi
Ultimate Strength	75,000 to 95,000 psi
Elongation (2-inch gage), min	21% *
Reduction in Area, min	30% **
Longitudinal Charpy V-Notch, min	15 ft-lbs at 40°F.

*Elongation (eight-inch gage), minimum 18 percent for bolts tested full section.

** Bolts over 2 to 2-1/2 inch, 22 percent min; over 2-1/2 to 3 inch, 20 percent min.

Notch toughness tests on specimens shall be performed according to Test Frequency P of ASTM A 673 and the notch shall be oriented perpendicular to the longitudinal axis of the anchor bolt. It may be necessary to heat the steel in order to meet the Charpy V-Notch impact requirements.

Anchor bolts, nuts, and washers shall be zinc-coated, as shown on the plans and specifications, according to ASTM A 153. Dimensions of the bolts shall be as shown on the plans.

Threads on the anchor bolts shall be 8UN series as specified in ANSI B1.1 and shall have Class 2A tolerances before coating. After coating, the maximum limit of pitch and major diameters may exceed the Class 2A limit by 0.021 inch for bolts 1 inch and smaller, and by 0.031 inch for bolts larger than 1 inch in diameter. Anchor bolt threads may be cut or rolled into the round bar stock.

Nuts for anchor bolts shall conform to ASTM A 563, Grade A, heavy hex. The threads shall be 8UN series as specified in ANSI B1.1 Class 2B tolerances, and tapped oversize after coating by not more than 0.021 inch for nuts 1 inch and smaller, or more than 0.031 inch for nuts larger than 1 inch. The nuts shall be lubricated as specified in Supplementary Requirement S1 of ASTM A 563.

Washers shall conform to ASTM F 436 for circular washers.

All bolts shall be furnished with certification, including results of yield strength, tensile strength, elongation, reduction of area, and charpy tests, with identification to the heat number of the steel, and to furnace lot number if heat treated. Anchor bolts for cantilever and truss sign supports shall have an identification stamped in the end of the hook to identify them to a specific heat number and the threaded end cross section to identify them to a specific test report prior to sampling the bolts for testing.

The Engineer will sample anchor bolts (including nuts and washers) for destructive testing at the following frequency:

Cantilever sign supports - 1 bolt per cantilever per heat.
Truss sign supports - 1 bolt per truss assembly per heat.
Other uses - 1 bolt per heat per project.

Additional bolts shall be ordered for sampling.

C. Overhead Signs on Bridge Structures.

1. **Plates.** Brackets and reinforcing plates shall meet ASTM B 209, Alloy 6061 T6.
2. **Angles, I-Beams, and Channels.** Aluminum shapes shall meet ASTM B 308, Alloy 6061 T6.
3. **Bolts, Nuts, Washers, and Lockwashers.** All nuts, bolts, washers, and lockwashers used in the erection and fabrication of the overhead sign structures on bridges shall be austenitic stainless steel; except, the bolts used for the attachment to the bridge shall be fabricated according to ASTM A 325 and galvanized according to AASHTO M 232.

894.09 DETECTABLE WARNING PANELS.

- A. **New Construction.** The Detectable Warning Panels shall have a minimum size of 1 foot by 2 feet. The panels shall be safety yellow color throughout the panel and consist of a surface of truncated domes aligned in a square grid pattern.
 1. **Dome Size.** Truncated domes in a detectable warning surface shall have a base diameter of 0.9 inch minimum to 1.4 inches maximum, a top diameter of 50 percent of the base diameter minimum to 65 percent of the base diameter maximum, and a height of 0.2 inch.
 2. **Dome Spacing.** Truncated domes in a detectable warning surface shall have a center-to-center spacing of 1.6 inches minimum and 2.4 inches maximum and a base-to-base spacing of 0.65 inches minimum measured between the most adjacent domes on the square grid.
 3. **Dome Alignment.** Domes shall be aligned on a square grid in the predominant direction of travel.
 4. **Size.** Detectable warning surfaces shall extend 24 inches in the direction of travel and the full width of the curb ramp landing.
- B. **Retrofit.** Retrofit panels will meet the same requirements as New Construction and, in addition, shall have a maximum thickness of 1/8 inch.

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